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CHARLES D. WALCOTT,
Secretary of the Smithsonian Institution.

ARTICLES

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SMITHSONIAN MISCELLANEOUS COLLECTIONS

VOL. III QUARTERLY ISSUE PART 1

THE STRUCTURE OF WING-FEATHERS

BY DOCTOR E. MASCHA

[The following paper on the "Structure of Wing-Feathers" gives an account of an investigation conducted by Doctor E. Mascha under the direction of Professor R. von Lendenfeld, of the Imperial German University in Prague. The original German text of this paper is to be published in the *Zeitschrift für wissenschaftliche Zoologie*.

Doctor von Lendenfeld, who was a competitor in the Hodgkins competition of the Smithsonian Institution, has more recently been awarded a grant in aid of his research on the anatomy of the flight organs, the investigation being continued under his direction by Doctor Mascha, as here described.]

I. INTRODUCTION

The object of this paper is in the first instance to give a detailed account of the morphology of the wing-feathers of birds as used in flight. As our knowledge of this subject is far from satisfactory, I have made a special study of the organs of flight, hoping that I might be able to supply needed and valuable information for those interested in the great problem of aerial navigation.

The remiges of *Columba livia* were first investigated. Although the structure of these feathers is in many respects simple and typical, several questions concerning the function of particular parts could be satisfactorily answered only by a comparative study of the wing-feathers of other birds. Through this extension of my investigation I was enabled to find out which parts are constant and therefore probably essential, and which not being always present are inferentially of secondary importance. Among the most noteworthy discoveries made through this comparative study are a knowledge of

the variability in the size and structure of the secondary fibers, the recognition of the importance of their ventral ridge, the variation of the hook fibers and the constancy of the curved fibers.

II. The Structure of the Remiges

1. *The Structure of Feathers in General*

According to the nomenclature adopted in this paper each feather consists of the following parts: (1) Quill or primary quill, (2) secondary quills, (3) tertiary fibers (*a*) hook fibers, (*b*) curved fibers.

The primary quill is the bearer of all parts of the feather. Its shorter proximal part is circular in section and hollow, its longer distal part more or less rectangular in section and filled with medullary air-cells. The primary quill is slightly curved downward and inward; on its sides the two feather vanes extend. They lie nearly in the same plane. The two vanes are nearly equal in the remiges attached to the ulna; distally the outer vanes diminish in breadth more rapidly than the inner. The outermost of the hand-remiges attached to the metacarpals and phalanges have a broad inner and a comparatively narrow outer vane. The vanes are composed of the secondary quills which rise obliquely from the upper part of the primary quill, and of the tertiary fibers rising in a similar manner from the secondaries. The tertiaries are closely connected with each other; together with the secondary quills they form the apparently continuous surface of the feather vane or feather plate.

2. *Material and Methods*

Remiges of the following species were examined:

Passeres: *Fringilla spinus, Turdus vulgaris, Garrulus glandarius.*
Coraciæ: *Merops apiaster, Galbula viridis.*
Bucerotes: *Buceros monoceros.*
Macrochires: *Cypselus apus, Micropus melba, Macropteryx mystaceus.*
Caprimulgi: *Podargus humeralis, Caprimulgus europæus.*
Striges: *Strix flammea, Bubo maximus, Bubo mexicanus, Nyctea nivea.*
Psittaci: *Chrysotis æstiva, Sittace cærulea, Stringops habroptilus.*
Cuculi: *Cuculus canorus.*
Musophagi: *Turacus albocristatus.*
Columbæ: *Columba livia.*
Tubinares: *Diomedea exulans.*
Anseres: *Cygnus olor.*
Accipitres: *Aquila chrysætus.*[1]

[1] The systematic arrangement adopted is that of F. E. Beddard, "The structure and classification of Birds." London, 1898.

This list, although small, comprises birds of most types of flight, my aim being not to examine many different species but only representatives of the different types. The remiges of *Columba, Cypselus,* and *Diomedea* were studied most carefully; those of birds not capable of flight did not fall within the scope of my investigations.[1]

I have taken no notice of the numerous new terms concerning the arrangement of the feathers proposed by Alix (1864, p. 10), Wray (1887, pp. 344–345) and others, the older divisions into hand-remiges and arm-remiges being quite sufficient for my purpose.

It was to be foreseen that the treatment of such brittle and hard material as the horny substance of feathers would present serious technical difficulties. Former investigators have left no record of the way in which their examinations on developed feathers were conducted. It is true that Strong (1902, pp. 148–151) has described his mode of procedure rather fully, but he speaks merely of the treatment of "feather germs."

I treated the material to be examined in the following manner: I took one of the three outermost hand-remiges, usually the longest, and one of the arm-remiges of each species of bird to be examined, and placed a portion of the vane on the slide mounted in balsam.

Then one of the secondary quills was cut off and the tertiary fibers, attached to it, removed to the slide by means of a sharp scalpel. In this way large numbers of isolated tertiary fibers lying in different positions were obtained and mounted in balsam. Parts of white colorless feathers became so transparent in this medium that recourse to staining was resorted to. It should be noted that of the numerous stains tried, only two proved useful: picric acid, which quickly produced a yellow coloring, too faint however to be effective, and safranin, which stains a deep color and gives good results when properly applied. I used the safranin in a semi-alcoholic solution and left the objects in it from six to twelve hours. After being stained the feathers were dried and then further manipulated. The most difficult part of the work, but at the same time the one that gave the best results, was section cutting with the microtome, in which operation the fragility of the material proved very troublesome. The specimens were placed in chloroform to expel the air, and imbedded in paraffin or celloidin. In cutting the paraffin

[1] The wings of birds not capable of flight have no hook fibers on the tertiaries, as their wings do not need to form such an impenetrable surface as is requisite in birds of flight. In the ostrich the tertiary fibers are entirely smooth (branchless); in the cassowary and the apteryx they show small thorn-like protuberances which are also present in the penguin, but somewhat longer.

blocks I successfully adopted the method of covering the top of the block with melted paraffin after each section, and congealing it by means of a current of cold air.[1] A very oblique position of the knife is essential to procure good sections. In the paraffin method I stained with safranin before imbedding. The sections were glued to the slide with Schällibaum's collodion-clove oil and cleared with xylol. Although thin sections could be made by this method it had many drawbacks. The sections frequently split, and while removing the paraffin with xylol numerous portions of them were lost. By experiment I found that the splitting was almost entirely obviated by the employment of celloidin, although it is true that the celloidin method also presented difficulties. It is hard to make as thin sections of celloidin blocks as of paraffin, and staining is much more difficult. If one stains (with safranin) before imbedding, the ether extracts even the strongest stain. If one stains the sections after cutting, the celloidin also takes the stain. The sections were at first made only on the two directions parallel to one of the two kinds of tertiary fibers. These proved to be very instructive for the exact study of the tertiaries but did not throw sufficient light upon the structure of the secondaries. To study these, sections were made vertical to the secondaries, which gave the desired information concerning them.

3. *The Primary Quill*

The morphology of the primary quill (fig. 6, *Htk*)[2] have already been fully discussed. Ahlborn (1896, p. 15–16) in particular has given a complete description of this part of the feather, illustrated by a sketch, and has drawn attention to the importance of its structure for flight. I therefore turn at once to the description of the parts composing the feather vanes, beginning with the consideration of the secondary quills.

4. *The Secondary Quills*

The secondary quills are the bearers of the feather-vanes. Just as they themselves spring obliquely from both sides of the dorsal part of the primary quill, so they bear dorsally the tertiary hook and curved fibers. Clement (1876, p. 282) has drawn attention to this in a somewhat different sense. He calls the plate, composed of the two vanes of a feather, *vexillum*, and the vane formed by the tertiary

[1] The method employed was described by Professor von Lendenfeld in *Zeitschrift für wissenschaftliche Mikroskopie und mikroskopische Technik*, v, 18, pp. 18–19.

[2] For figures see plates at end of the paper.

fibers on each side of the secondary quills *vexillum primitif*. After him Strasser (1885, p. 197) noticed these structures, and introduced the expressions secondary quills and secondary vanes, to distinguish the former from the primary quill and the latter from the primary vanes of the whole feather.

The secondary quills arise dorsally from the sides of the primaries, and extend obliquely outward. The angle between them and the primary quills is about 50° in the arm-remiges and changes but little in the whole length of these feathers in both vanes. It is subject to greater variations in the hand-remiges. Here it is greatest at the base of the feather (about 50°), towards the end of the feather it becomes smaller, the outermost secondary quills rising from the primary quill at an angle of only 20–25°. In the central broadest part of the hand-remiges this angle is 30–40°. In the outer vane of the hand-remiges the angle is always smaller than in the corresponding part of the inner vane. At the distal end of the feather the secondary quills are curved and their tips turned in the direction of the continuation of the primary quill. The secondary quills are for the greater part of their length considerably compressed laterally, becoming band-like. They are highest at their origin from the primary quill and decrease in height outwards, finally tapering to a fine point (fig. 12, *a, b, c*).

A few words must be said here concerning the histological structure of the secondary quills. Like the primary quill they appear as horny tubes (figs. 1, 2, 3, 4, *Hns*) enclosing a medullary substance or core composed of large polyedrical cells filled with air (figs. 1, 2, 3, 4 *Mks*). Klee (1886), p. 92–30) has pointed out that the cortex and the core are essentially different, but that both arise from similar elements, at first homogeneous. Davies (1889, pp. 588–589) has fully and clearly described this process of conversion of the intermediary cells into cortical and medullary substance. He says: "The modification consists in a considerable increase in size of the central space which, in horned cells, contains the nucleus, combined with a change in the form of the cell." The relative positions of the cortex and the core are shown in the transverse sections of secondary quills represented in figs. 1–7, 29.

Two types of secondary quills can be distinguished. In the first, which is by far the most frequent, the core is irregular, composed of many layers of irregularly arranged core cells and the interior of these secondary quills presents a honeycomb-like structure. In the second type, met with in the Owls and Caprimulgi (figs. 2, 4, 7, 29), the core cells are arranged in a single vertical layer, irregularly

polyhedral and overlap each other like roof slates. Here and there a more irregular polyhedral cell is interposed between the others. The transverse sections show that these quills are not simple bands but curved more or less transversely, convex on one side and concave on the other. The manner in which the secondary quills, which are highest at their proximal end, become lower toward their distal end is correlated in many birds to that curvature in such a way that the curvature is greatest where the quills are highest and decreases with the height outward, finally disappearing almost entirely near the distal end. Strong (1902, pp. 158–159), draws attention to an extension of the lower margin of the secondary quills which he terms "the ventral ridge," and which he represents as a constant character. In early stages of the development of the feather this ridge is said to be very large, being much reduced later. This ventral ridge of the secondary quills, which also appears in the covert feathers of the wing (fig. 5), is functionally a very important character of all remiges. It is small in *Columba, Cypselus* and others, larger in the Caprimulgi (figs. 2, 4, 7, *Hnl*), still further developed in the owls (fig. 29, *Hnl*) and in many water birds, and largest in *Aquila* and *Diomedea*. Hand in hand with the development of this ventral ridge goes the development of the curvature. The great development of the ventral ridge, combined with the strong curvature of the secondary quills in *Aquila* and *Diomedea* probably enables these birds to perform the sailing flight characteristic of them. It must be noted, however, that the ventral ridge is very well developed in owls and various water birds also, which are not such excellent sailors of the air as the albatross and the eagle. Ahlborn (1896, p. 20) describes a peculiarity of certain parts of the remiges in the duck, the swan and other birds. He says that portions of the lower sides of these feathers seem to be covered by a fine membrane, this appearance being due to the fact that here the secondary quills are not only connected with each other dorsally by the tertiary fibers but also ventrally by delicate membranous extensions of their ventral margins, which bridge over the spaces between them. These extensions enclose a right angle with the band shaped secondary quills from which they arise and exactly fit on the ventral margins of the quill in front, to which they adhere on account of their intrinsic elasticity. This membranous extension of Ahlborn is only the strongly developed ventral ridge of the secondary quills.

The decrease outwardly in the height of the secondary quills is uniform in some birds but not so in others. In the latter there is a sudden decrease in height in the secondaries of the broad inner

vane about half way between the primary quill and the margin of the feather, or nearer to the former. Here also the ventral ridge suddenly becomes lower in the region where the height of the quills themselves abruptly becomes less. In the vanes with uniformly decreasing secondary quills the central margins of these quills stand out free, so that one clearly sees the ribbing on the under side of the feathers of which Parseval (1889, p. 70) has spoken. It is quite different in the Striges, Accipitres and Diomedea, birds described by Ahlborn. Here the secondary quills are very high and markedly concave at their point of origin and the ventral ridge is of considerable size in the basal part of the secondary quill; being nearly vertical to the quill itself it lies almost horizontally, and extends to the convex rear side of the secondary quill in front of it (fig. 33). In the middle of the length of the secondary quill the ridge becomes so small and the angle between it and the quill to which it belongs so large, that the ventral connection of the secondary quills formed by these ridges ceases. Outside this well marked line their ventral margins are free. If one looks at the ventral side of the feather it is noticed that in the proximal third of the vane the light is reflected from the ridges producing a silvery luster which ceases rather suddenly at a line parallel to the primary quill, an appearance which can be observed more or less clearly in the remiges of all these birds.

In the development of this ventral ridge two types can be distinguished. One is represented by the remiges of *Columba*, the other by those of the Striges, Tubinares, and Accipitres. In the first the ridge is a stout, low ventral projection of the cortex of the secondary quills and appears wedge-shaped in transverse sections (figs. 1, 3). In the second it is a band-shaped membrane thin down to its base, attached vertically to the high and markedly convex secondary quill (fig. 29). These types are connected by transitional forms. A peculiar development is observed in the secondary quills of the remiges of the Caprimulgi in which the ventral ridge is not sharp but blunt, of uniform thickness throughout and rounded at the margin. On the upper edge also the secondary quill bears a ridge, which is broad, low and rounded (figs. 3, 4, 29, *Vd*), and of no functional importance for flight.

The tertiary fibers are attached to the secondary quills in a complicated manner. In examining sections parallel to one of the two kinds of tertiary fibers, I could only indistinctly make out their junction, but the sections vertical to the secondary quills were much more instructive. I could find no description of this apparatus in

the whole literature on the subject. The works of Haecker (1890, pl. IVa, 1900, pl. XIV) contain some figures of transverse sections of secondary quills, which are not absolutely correct, but are essentially better and more true to nature than some others (*e. g.*, Chadbourne, 1897, pl. Ia). Unfortunately I was not able to see the treatise of Jeffries (1883) mentioned by Strong (1901, p. 160). Strong himself (1902, figs. 7, 8, 9, pl. 1) has published several good figures of transverse sections of secondary quills. Since, however, he made such sections of covert-feathers only, it is natural that the results I obtained deviate considerably from his. It seems that these formations are much more complicated in the remiges than in the covert feathers. According to my observations in the latter they have the following structure: Under the starting points of the tertiary fibers there arises from each side of the secondary quill a longitudinal ridge, not vertical but extending obliquely upward (figs. 3, 4, *G*), which consists entirely of horn-substance. Its outer surface is smooth and continuous with the side of the secondary quill. Its inner side, which is turned toward the upper part of the secondary quill, is grooved, the grooves being separated by parallel secondary ridges (figs. 3, 4, *L*), which extend obliquely upward and outward. These ridges are highest at their origin and decrease in height distally; in the transverse section they appear like the teeth of a comb, and become shorter the further they are away from the secondary quill, the last being a slight prominence only. The ridges themselves are broadest at the base and grow thinner above. Their number in the sections varies from two to four and they may be more numerous in the secondary quills of larger feathers. In the small covert-feathers this main longitudinal ridge occurs, as has been described by Strong, but here the secondary ridges rising from its inner face are absent. The most difficult question to answer is, how the outer edge of the main ridge is formed. Without having reached a perfectly satisfactory conclusion, I think I may pronounce it as probable that it is not smooth but interrupted by incisions lying between the ends of the secondary ridges. If this were not so, in a succession of transverse sections of secondary quills the secondary ridges would always terminate at exactly the same level, which, as serial sections show, is not the case. The level and the appearance of the edge of the ridge vary in every section, and on this fact the above supposition is based. In the grooves between the successive secondary ridges lie the ventrally thickened margins of the proximal parts of the tertiary fibers. In sections one sees the first between the secondary quill and the first secondary ridge, and the second be-

tween this and the second secondary ridge (figs. 3, 4). If there are more than two secondary ridges in the section, the third and fourth are so small and the grooves lying between them so shallow, that the position of the fiber-sections relative to them becomes doubtful. In surface views one sees parallel lines at the side of the dorsal ridge of the secondary quill. These lie between the basal parts of the tertiary fibers and enclose an angle with the secondary quill considerably more acute than the angle between the tertiaries and the secondary quill. They cross the direction of the latter at angles of 20–25°. In a line parallel to the secondary quill, which is the edge of the longitudinal ridge, these lines, which are the free margins of the secondary ridges described above, terminate suddenly (fig. 20, *L*).

If we combine the results of these observations we see that the basal parts of the tertiary fibers lie between the partitions like the bars of a gridiron. These bars arise from the inner face of a longitudinal ridge arising from the side of the secondary quill and extending obliquely upward. The bars decrease in height outwardly and finally pass into the margin of the longitudinal ridge. The thickened ventral margins of the proximal portions of the tertiary fibers are enclosed between these bars; beyond the margin of the longitudinal ridge they are free. At the margin of the ridge a sharp bend occurs in the ventral margin of the tertiaries, its free outer portion enclosing a larger angle with the secondary quill than its proximal part. In the nearly symmetrical vanes of the distal remiges the secondary quills extend almost horizontally and, therefore, the two vanes also are nearly horizontal. In the broad inner vane of the hand-remiges on the other hand, only the basal part of the secondary quills extends horizontally. Farther out they are at first bent a little downward but rise up toward their ends. The inner feather-vane therefore appears bent slightly in the form of an S, the hind margin of the feather being distinctly turned up. In the outer vane the secondary quills, which are here very short, are curved slightly downward. In the remiges of many birds of prey the inner vane suddenly becomes narrower in the upper third of its length. In this case the inner vane has a distinctly S-shaped curvature in its broad, proximal portion, the outer edge being much raised, while this curvature suddenly ceases where the broad, proximal part passes into the narrow, distal part, the latter being like the front vane slightly bent downward. Since according to Ahlborn (1896, p. 18) the S-shaped curvature of the inner vane of the succeeding remiges serves to insure a close overlapping of all parts

of the wing, it is undoubtedly of interest that in the wings of these birds this curvature is developed only so far as the feathers really overlap each other.

The secondary quills have the same structure in all remiges of a wing, but we observe a regular variation of their size in the different feathers of the same wing and in the different parts of each feather. An increase of the stiffness of the secondary quills is noticeable, as we proceed from the proximal to the distal part of the wing. Hand in hand with this goes an increase of the development of the ventral ridge, which is relatively small in the arm-remiges but attains enormous dimensions in the hand-remiges of *Diomedea*, the Accipitres, and Striges. At the same time the outer vane in the hand-remiges becomes constantly narrower, as compared to the inner, and at the same time stiffer and firmer. The secondary quills in the narrow vanes are basally just as high as the secondary quills of the corresponding broad vanes lying opposite them, and they do not terminate in fine threads like those of the broad vanes but are only slightly pointed at the end. The elasticity of the secondary quills contributes to keep the elements of the narrow outer vane in their proper position and order.

Besides these differences of size in the secondary quills of the different feathers of the wing, similar variations occur also in the different parts of each feather as mentioned above. The supposition is obvious that the secondary quills are thickest and highest at the base, and that they should become lower towards the end of the feather, where the primary quill also decreases in thickness. Such conditions are really found in the arm-remiges of all birds and in the outer hand-remiges of *Diomedea*. In the outer hand-remiges of numerous birds, such as the Columbinæ, Coccygomorphæ, Cypselidæ, Strigidæ, and Natatores, however, the secondary quills are moderately high at the base of the feather, increase gradually in height distally and attain their maximum height at or just beyond the middle of the feather. Measurements in corresponding portions of different hand-remiges gave the following results:

Species.	Length of Whole Vane.	Height of Secondary Quills.		
		3 cm. from the Base.	Middle of the Vane.	3 cm. from the Tip.
Macropteryx mystaceus.	18 cm.	300 μ	389 μ	233 μ
Bubo maximus.	28	550	910	700
Cygnus olor.	26	489	1,223	678

The secondary quills are measured close to the primary quill near their point of origin, that is at the point of their greatest height.

A comparison of these measurements shows how great, especially in *Cygnus olor,* is the increase in height of the secondary quills from the base to the middle of the feather. The decrease in height towards the end of the feather is gradual, the secondary quills 3 cm. from the tip of the feather are sometimes considerably higher than at a similar distance from the base.

We know that the development of the parts corresponds to the demands made upon them and that in general an organ is most strongly constructed and most capable of resistance exactly at the point where this strength is most needed. The task of these feathers is to bear and to raise the bird's body, by pressing on the air below, therefore the secondary quills are highest and as a consequence the feather vane the strongest and most capable of resistance where the greatest force is to be withstood. The wing being a concave surface, we can assume that its parts will be subjected to different pressures, and further, that where the pressure is greatest the feathers will be strongest. Apart from the variations of curvature we must also take into consideration the length of the feathers relative to the whole wing. In *Diomedea* the arm-remiges are short in comparison to the length of the wing and the secondary quills highest at the base. Where the remiges are relatively long, the secondary quills attain their maximum height in or just above the middle of the feather. The functional meaning of this correlation is however not quite easy to make out, but physiologists and flight-engineers should pay due attention to the fact that such morphological peculiarities are always correlated to the mechanical or other demands.

In addition to these general remarks on secondary quills I must mention the peculiar structure of the margin of the outer vane of the three outermost remiges in owls, which are toothed or rather comb-shaped (figs. 31, 34 *Z*). The finer structure of this comb however seems not to have been understood; its teeth are nothing else than the tips of the secondary quills of the outer vane, which in this instance, do not bend inward terminally and lie close together, but, after extending in a straight line for some distance, suddenly bend outward, so that their ends stand almost at right angles to the direction of the primary quill. Of course the separate teeth of this comb, as parts of the secondary quills, are provided with tertiary fibers (fig. 34). It is to be noted that this formation, which is absent in only few species of owls, as for instance in *Nyctea nivea,* a day bird of prey, is to be found also in some of the Caprimulgi (*e. g.,* some species of *Podargus,* fig. 30, *Z*). On the other hand, they seem to be entirely absent in the genus *Caprimulgus* itself, nor do they occur in *Stringops habroptilus,* although it also is a night bird.

5. *The Tertiary Fibers*

Between the secondary quills lie two systems of fine fibers, which in their close connection form the greater part of the feather plate that acts on the air in flight. The tertiary fibers spring from the upper part of both sides of the secondary quills, and form two little fiber-vanes (fig. 22). In a work by Schroeder (1880, pp. 3–14) there is a critical discussion of all papers on this subject published up to 1880. Nitzsch (1840, pp. 5–15) was the first to give a fairly correct description of these structures, with a number of good drawings. In 1887 Wray made an attempt to construct an enlarged model of a feather and from it prepared some very schematic drawings (1887, pl. XII).

Among works of later date are Ahlborn's (1896, pp. 17–21) and Strong's papers (1902, pp. 156–161), to which and to a small number of others I shall have occasion to refer. What has been said with regard to the nomenclature of the secondary quills holds good for the tertiary fibers also. Uniformly termed "barbules" in English and French, they figure in German works promiscuously as "Strahlen," "Nebenstrahlen," "Fäserchen," "Fiedern II. Ordnung," "Fiederchen," etc. We must distinguish two essentially different kinds of tertiary fibers, one being on the whole straight and bearing on the ventral side several hooks, the hook-fibers (fig. 21, *Hkf*); the others being curved and without hooks, the curved fibers (fig. 21, *Bgf*). This division of the fibers into two kinds seems to be justified also by the fact that they start from different sides of the secondary quills.

If we cut sections through the feather vane, according to the method before described, in the direction of the hook-fibers, or in that of the curved fibers, in the first case, between the transverse sections of every two adjacent secondary quills we get a longitudinal section of a hook fiber and a series of transverse sections of curved fibers, and in the other case, a longitudinal section of a curved fiber and a series of transverse sections of hook-fibers (figs. 24, 25). The series of transverse sections of different parallel fibers thus obtained are identical with a series of transverse sections of the same fiber. Accordingly, we can reconstruct from these sections any particular fiber we like.

A. *Hook-Fibers*

The structure of the hook-fibers is as follows. The proximal portion is band-like, transversely curved so as to become groove-like, the concavity of the groove being turned towards the secondary quill, from which the fibers arise (fig. 26). This band-like basal portion

is continued in a distal part which is more rod or thread-like, and from which numerous projections arise; the proximally ventral hooks characteristic of these fibers, and the distally ventral and dorsal spines lying in pairs opposite each other.

We will first consider the hook-fibers of the remiges of *Columba livia* as a typical example (figs. 2, 26). Here the proximal band-like portion forms about half of the whole fiber. It is transversely bent, its upper half being vertical, the lower turned obliquely toward the secondary quill and the front. As transverse sections clearly show, the fiber is here not only groove-shaped, but thickest at its upper margin, decreasing in thickness downward and passing finally into a thin ventral membrane. Only at the proximal end of the fiber the ventral membranous extension is absent. In studying transverse sections through the secondary quills (figs. 3, 4, 26) we see that in the first two the hook-fibers are thickest at the base and become thinner towards the top; in the third section the fiber is nearly equally thick at the top and the bottom and in the next section the reversed relation, holding good for the remainder of the band-like part, sets in. At the upper margin a distinctly recognizable swelling (figs. 8, 26, *Wlt*) is to be seen, which generally disappears distally, where the lower part of the fiber band passes into the thin ventral membrane mentioned above. The dorsal swelling is sometimes, particularly when pigment is present, plainly visible even in surface views. The histological structure of this part of the hook-fiber is as follows: If we look at a hook-fiber from the side we sometimes notice in its proximal half a row of oval spots usually with dark margins, their long axes extending obliquely upward and backward. These spots were first noted as depressions, later authors recognized them as dried-up nuclei (fig. 9, *k*). Schroeder (1880, p. 30) was the first to state that each fiber consists of a single row of cells. This supposition found confirmation in the subsequent investigations of Klee (1886) and Davies (1889).

The nuclei of the cells forming the fiber lie in its thinner portion and are clearly visible. Apart from the nuclei, one can frequently perceive the cell limits also, either as fine, dark lines, as I found them especially in the hook-fibers of *Cypselus apus* (fig. 16, *Zgr*) after staining, or as clear, pigmentless lines separating the upper portions of the cells in which the greatest amount of pigment is contained (figs. 8, 9, 10). Strong (1902, p. 156) has fully described these cell limits and has drawn particular attention to the fact that they first extend from the upper margin obliquely forward and downward and suddenly turn in the proximity of the nuclei, being

continued obliquely downward from here toward the base of the fiber. At the end of the proximal band-like portion of the fiber the lower halves of these cell limits change their direction and form a straight line with the upper halves, which in the distal part of this portion of the fiber attains a convexity towards the base (fig. 16, *Zgr*). The transverse curvature is not the same throughout the proximal portion of the fiber, being slightest at the base and becoming greater distally. The upper and lower part of the band enclose an angle which is very obtuse proximally and becomes more acute distally; at the distal end of this portion of the fiber it is nearly a right angle (fig. 26). The series of transverse sections show that the difference in thickness between the upper, vertical and the outwardly lower, nearly horizontal part becomes greater distally. The upper vertical and the lower horizontal part of the fiber separate distally. A little below the spot where these separations occur the vertical upper portion passes into the thread-like, distal part of the fiber. In *Columba livia* the lower, horizontal membranous part terminates in several large lobes narrow at the base and broadened distally like leaves (fig. 8, vnL_1). The upper portions of these lobes stand vertical and enclose with the under ones an angle of nearly 90°. *Columba livia* is the only bird in which I have met with such high development of these lobes (fig. 26, VnL_2). In others the lobes appear as digitate processes, one or two in number, turned down distally as in *Cypselus, Diomedea, Nyctea, Podargus* (figs. 9, 11, 12, 13, *VnL*) and others. Each lobe springs from a different cell and is to be conceived as a simple cell-diverticulum.

Hook-shaped extensions hang down from the lower side of the distal thread-like portion of the hook-fibers which forms the continuation of the upper thickened portion of the basal part. The bases of these hooks enfoliate the fiber. The hooks themselves are band-like, twisted in their upper part, and terminate in a strong backward turned spine (fig. 8, *K*). While the greater part of the band forming the hook is thin its end is thicker and forms a sort of swelling which bears the short terminal point, which turns backward to form the hook. In *Columba livia* and in numerous other birds 4 or 5 hooks occur on each hook-fiber (figs. 8, 10). I found fewer hooks in *Cypselus* (fig. 11), *Micropus melba, Macropteryx mystaceus,* where only 2 to 4 are present, and more in *Diomedea* (fig. 9) where 6 to 8 are to be found on each hook-fiber. It is usually relatively broad, rarely long and slender, as in *Diomedea,* the Striges, and Caprimulgi (figs. 9, 12, 13); those nearest the base of the fibers are the shortest and are directed vertically downward.

Each succeeding hook is a little longer and directed more obliquely forward. While further differentiations of the hooks in general do not occur, in *Turacus albocristus* and in *Cuculus canorus*, on the anterior margin of the proximal hooks I found one to three small spines which gave them a peculiar appearance (figs. 14, 15). In the proximity of the hooks the transverse sections of the fiber itself changes. They are regularly oval where the last lobes of the ventral membrane arise. Farther out they become curved again, but the curvature is here far slighter than in the proximal portion of the fiber and the concavity turned toward the opposite side. The hooks are ventral projections of the successive cells forming the fiber. Beyond the last hook the fiber becomes rapidly thinner and gives off upward and downward, not as Nitzsch (1840, p. 14) erroneously supposed laterally, pairs of spine-shaped projections and terminates in a thin thread of varying length. The spines are the most variable parts of the whole hook-fiber. They are paired projections of the cells which form the distal portions of the fiber, each cell having two, a ventral and a dorsal one. The ventral spines are as a rule longer than the dorsal. The spines extend obliquely outward, the upper ones upward, the lower ones downward. They are broadest at their origin, become thinner distally and terminate in fine points. The proximal, ventral spines lying next to the hooks are blunt and frequently slightly curved in the form of a hook. They are transitions between the hook-shaped cell processes and the spines with straight-pointed ends. While, however, in the region of the hooks the fiber cells have no dorsal processes, in the distal, spined part of the fiber the cells have dorsal as well as ventral processes (spines). The spines originate from the distal, broader side of the cells, which here have the shape of flattened cones and are attached to each other in such a way that the narrow, proximal end of each is inserted into the broad, distal end of the next foregoing. The first two proximal, dorsal spines sometimes become very large and attain a lobose shape. This is especially well developed in the Cypselomorphæ and in most water birds (figs. 17, 22, W_2). These lobes lie horizontal, are directed towards the margin of the feather and extend as far as the next hook-fiber. In the hook-fibers of the proximal portions of the secondary quills, these lobes are smaller and more pointed than in the distal portions, where they become larger and relatively broader. Fatio (1886, p. 257) says of the spines of the hook-fibers of the feathers of water birds in general that "they are very long and numerous and by their irregular arrangement make the feathering bulky and so afford protection against the water." In the

microphotographs of the surface of a wing feather of *Cygnus olor* one sees the strongly developed dorsal spines very plainly (fig. 23, W_2). Surface views show that each hook-fiber is curved in a horizontal plane, the convexity being turned towards the secondary quill from which it arises. This curvature is confined to the central part of the fiber. The proximal and distal parts of the fiber remain straight and lie in the same straight line (figs. 17, 18, 19, 22). The upper, thickened margin, which is vertical in the proximal part of the fiber, becomes oblique in the neighborhood of the hooks, inclining above toward the secondary quill; distally it resumes its former vertical position. A similar twist, more or less pronounced, is observed in the hook fibers of all birds with the exception of the owls and Caprimulgi, where the upper margin of the fiber is vertical throughout its whole length.

The ventral part of the proximal band-like portion of the fiber, which terminates in the processes of the ventral membrane, is in *Columba* about as long as the distal portion; in smaller birds like *Fringilla* and also in the Psittaci, the proximal part is longer than the distal; in the Striges and Caprimulgi the distal part greatly exceeds the proximal in length (figs. 12, 13), this being one of the differences between the remiges of the diurnal and nocturnal birds.

The most striking peculiarity of the remiges of the owls is the down covering the dorsal side particularly of the proximal part of the broad inner vane, which gives them a velvety appearance. This velvet-like down consists of the lengthened distal portions of the hook-fibers. Fatio (1886, p. 257) says that they are long, slender and covered with numerous lateral spines (barbicels), which on account of their length and irregular arrangement make the fiber appear like a down feather. The proximal band-shaped part of the hook-fibers of the remiges of owls (fig. 12) has the same structure as in other birds. The terminal processes of the ventral membrane are usually one, less frequently two in number. They are small, narrow and show a slight hook-shaped curvature. In the region of the long and thin fourth and fifth hooks, the fiber is very narrow, and here the cell limits, usually indistinct, are sometimes conspicuous enough. The most remarkable feature of the remiges of owls is the extraordinary development of the distal, thread-shaped part of their hook-fibers. These terminal threads consist, according to the position of the fibers, of a row of 10 to 50 cells, each one bearing one or two peculiar, long and very thin spines (fig. 12, *W*). The dorsal spines are not raised but lie horizontal, so that they point inward toward the primary quill of the feather. The ventral spines

do not extend downward but raise themselves and point toward the margin of the feather.

The spines of adjacent hook-fibers therefore cross each other at an angle of about 90°, and thus form a system of rectangularly crossing threads similar to that formed by the hook and curved fibers. It is this peculiar structure of the distal portion of the hook-fibers which gives to the remiges of owls their great softness.

If one reflects that the distance between the secondary quills amounts only to 250 to 300 μ while the hook-fibers reach a length of 2 mm., it becomes clear that the hook-fibers attached to one secondary quill project a good distance beyond the next one, and often reach the second, or even the third or the fourth secondary quill. The many long terminal threads of the hook-fibers thus forming several overlapping layers, together with their numerous rectangularly crossing spines, form a dense, felt-like mass on the dorsal side of the feather. The constituent parts of this mass are prevented from becoming deranged through exterior mechanical influences by an extremely interesting arrangement. If one cuts through the proximal portion of the feather vane parallel to the direction of the hook-fibers and slightly magnifies the section thus exposed, it is seen that the proximal band-shaped portion of the fiber lies almost horizontal and that the distal part rises abruptly up at an angle of 30 to 40° (figs. 12, 32).

The hook-fibers of the Caprimulgi are very similar (fig. 13) to those of the owls, but the proximal band-shaped part of the hook-fibers of their remiges is relatively short and the terminal threads considerably lengthened. There are three to five rather narrow hooks, the distal ones being considerably longer than the proximal. The limits of the cells forming the fiber are often clearly recognizable in the hook region on account of their being somewhat raised and also on account of their color. As the hook-fibers of the remiges of the owls, so also those of the remiges of the Caprimulgi are distinguished from the hook-fibers of other birds by the peculiar development of their thread-like, distal part. In the hook-fibers of the first hand-remiges of *Podargus humeralis,* the proximal, band-shaped part is 200 μ, the terminal thread 2.3 mm. long, that is, more than eleven times as much. While, however, the terminal threads of the hook-fibers of the Striges bear a great number of spines dorsally and ventrally, such processes are entirely absent on the terminal part of the *Caprimulgus* hook-fibers. There are indeed immediately beyond the hooks one or two dorsal spines and four or five ventral the first remex. In the lower proximal third of this vane

ones, but such nearly spineless hook-fibers are not met with in the remiges of any other birds. All the other conditions described as present in owls, such as the teeth on the outer vane of the first hand-remex, the down on the upper surface, the upraising of the terminal threads and the overlapping of the layers of the latter, are also met with in the remiges of Caprimulgi (figs. 13, 30). Clark (1894, pp. 569–570) arrived at the result that these two groups agree in being aquincubital, a character which he considers of importance, and that the number of rows, the arrangement of the coverts and the relative position in the hand-remiges is the same in both. On the other hand, the number of hand-remiges in the Striges is always greater than in the Caprimulgi. To this we can now add that the Striges and Caprimulgi possess peculiar feather structures common to both through which they deviate from all other birds.

The differences between them are the different development of the ventral ridge of the secondary quills, which in Striges is high and sharp while in Caprimulgi it is short and blunt, and the different structure of the terminal threads of the hook-fibers, which in the former possess numerous spines, while in the latter they are nearly spineless. Common to both are the length and upraising of the terminal threads of the hook-fibers, which form the down on the dorsal side of the feather, and the comb-like structure of the anterior margin of the first hand-remex.

The hook-fibers spring at an angle of 30 to 40° from the dorsal part of the inner side of the secondary quill. All the hook-fibers of a secondary quill are parallel to each other and equally far apart. It is to be noted that the distance between adjacent hook-fibers is nearly the same in all birds, varying only from 20 to 30 μ. In *Cypselus* this distance is 25 μ, in *Columba* 22μ, and in *Diomedea* 27 μ.

The hook-fibers arising from one secondary quill extend as a rule about as far as the next secondary quill, excepting that in the Striges and Caprimulgi they extend, as we have seen, much further, although unusually long hook-fibers occur in some other birds also. In *Diomedea,* for instance, the spined terminal threads of the hook-fibers extend to the second secondary quill. The hook-fibers are not of equal length in different parts of the wing of the same bird, and are different even in the different parts of the same feather. These local variations in form and size, met with in all birds, are particularly striking in *Nyctea nivea.* In this owl the hook-fibers on the broad inner vane are longer than on the outer vane. Considerable variations occur also in the vanes of different feathers. I will illustrate this by a few measurements made in the inner broad vane of

the hook-fibers are longest. Here the proximal band-shaped part of the fibers measures on an average 250 μ in length, the terminal thread which is composed of about fifty cells, 1.77 mm. and the whole hook-fiber 2.02 mm. The terminal thread is about eight times as long as the proximal band-shaped part. Towards the middle of this vane the proximal part of the hook-fibers becomes longer, measuring 300 to 350 μ, and the terminal thread, here composed of only about 30 cells, shorter, measuring only 70 μ, so that the whole fiber is only 1.27 to 1.32 mm. long, and the terminal thread about three times as long as the proximal part. Near the tip of the feather we find hook-fibers, the proximal part of which measures 200 μ and the terminal thread, here composed of only 8 to 10 cells, 270 μ. Here the whole fiber is 470 μ long and the terminal thread only slightly longer than the band-shaped proximal part. The hook-fibers also, arising from the same secondary quill, are not all alike. The proximal band-shaped part remains fairly constant but the terminal thread varies considerably. Let us take a secondary quill of the middle of the above-mentioned feather vane: The proximal fiber portion on the whole length of the secondary quill is 300 to 350 μ long.

The terminal thread is shortest and composed of fewest cells in the fibers arising proximally, nearest the main quill. Distally the terminal thread lengthens and the number of cells composing it increases until just beyond the middle of the secondary quill; further on toward the feather margin it again becomes a little shorter.

In the anterior narrow vane of the same feather the hook-fibers are considerably shorter than in the broad inner vane. Measurement in the middle portion of the feather gives an average length of 600 μ for the hook-fibers of the narrow vane as against 1.28 mm. for the hook-fibers in the corresponding part of the broad vane. The proximal band-shaped part is 300 μ long in the narrow vane, that is to say, just as long as the terminal thread. There are four or five hooks on the fibers of both vanes.

In this place I may mention a few developments of hook-fibers characteristic of the feathers of owls. The cells forming the terminal thread bear one or two spines each, but whether one or two depends upon the position of the fiber. In the middle of the narrow outer vane of the distal hand-remiges the terminal threads of the hook-fibers are composed of about ten cells each, and provided with ventral spines only. In the middle of the broad inner vane the terminal threads of the hook-fibers arising from the proximal parts of the secondary quills are composed of cells which likewise bear

only ventral spines; these ventral spines are, however, extraordinarily long. In the terminal threads of the hook-fibers arising toward the middle of the secondary quill, spines appear on the dorsal side also. Where dorsal spines are developed the ventral ones are shorter than elsewhere. Below the middle of the secondary quill the dorsal and ventral spines are equal and about half as long as the ventral spines of parts where no dorsals are developed. The down becomes gradually thicker outwards and is thickest and highest beyond the middle of the feather-vane, measuring transversely, just where the terminal threads of the hook-fibers and the spines attain their greatest length (fig. 32). In some birds the proximal, band-shaped part of the hook-fiber is remarkably strong when compared with the terminal thread. In *Cypselus* the proximal portion is actually longer than in *Podargus,* the hook-fibers of which have a much greater total length than those of *Cypselus.*

B. *The Curved Fibers*

Opposite the hook-fibers and a little lower down there rises from the side of each secondary quill a second system of fibers, the curved fibers (figs. 3, 4, *Bgf*). At first they extend obliquely outward at an angle of 35 to 40°. At about half their length they suddenly bend toward the secondary quill from which they arise in such a way that their distal portion comes to lie parallel to the latter (fig. 21). Although many anatomical characteristics indicate that the curved fibers and the hook-fibers are homologous, yet these two kinds of fibers are in many respects morphologically and functionally so different that a special terminology and a separate description are necessary.

In the curved fibers as in the hook-fibers two parts, a broader, proximal, band-shaped portion and a slender terminal thread can be distinguished (figs. 9, 28).

The fiber increases in breadth from its point of origin up to the middle of its length and then narrows again. In sections vertical to the secondary quill one can see (figs. 3, 4, 27), that the proximal ends of the curved fibers are band-shaped with a thickened ventral and a thin dorsal margin. Where the fiber leaves the longitudinal ledge on which its basis rests, the two margins become equal in thickness. Further on, the dorsal margin remains stout while the ventral one becomes thin, membranous and sharp. So far the curved fibers resemble the hook-fibers, but a difference between them can already be noticed here. In the proximal part of the curved fibers the strip forming the upper margin is not merely thickened, as in

the hook-fibers, but appears involuted (fig. 28, *R*). Klee (1886, p. 18) was the first to show that the dorsal margin of the curved fiber is not thickened but involuted to form a groove in which the hooks of the hook-fibers are inserted. As before-mentioned these fibers are transversely bent in the shape of a groove. The concavity lies towards the secondary quill from which the fiber arises. It is most pronounced above and flattens out below, the section being an evolvent (fig. 27, *R*). Perhaps one may consider the slight thickening of the upper margin in the proximal part of the hook-fiber a formation corresponding to the involution of the curved fiber (fig. 26, *Wlt*). The sections show that the fiber is thickest at the dorsal involuted margin, decreases in thickness downward and thins out to a fine membranous lamella below. This lower lamellate portion has not the same curvature as the upper part but displays toward its margin an inclination to bend in an opposite direction so that the transverse section becomes slightly S-shaped. The curved fibers like the hook fibers consist of a single row of cells lying one behind the other. A row of nuclei extending obliquely upward and outward is clearly visible (fig. 27, *K*), and one can also make out the cell limits.

The ventral margin of the proximal part of the fiber is continuous up to the bend, or only interrupted by shallow incisions so as to appear somewhat wavy. The dorsal involuted margin retains its direction, the diminution of the fiber in width toward the end is caused only by the falling back of the ventral margin. In the region of the bend three or four tooth-like projections are observed at the upper, here less strongly involuted margin of the fiber. These teeth are turned backward and pointed. The middle ones are usually best developed (fig. 27, *Zf*), and correspond to a certain extent with the hooks on the hook-fibers. In cases where the hooks are broad, the teeth also are large, while in the case of birds whose hooks are long and thin, the teeth are often very small and hardly discernible. The first case is exemplified by the Psittaci, Columba and Anseres, the second by *Diomedea* and the Striges. It is remarkable that these tooth-like projections, which are not particularly difficult to see, have hitherto been mentioned in only a single description of feathers (Wray, 1887, p. 421, pl. XII, fig. 2). They have either quite escaped the other observers, or have appeared to them not worthy of notice. I believe that their function is far from unimportant.

In and beyond this region the ventral margin is divided by several deep incisions into a number of processes. These processes are

triangular, pointed distally and sometimes slightly curved hook-like at the end (figs. 27, 28, vnL_2). Ahlborn (1896, p. 20) mentions these processes in his description of the curved fibers and calls them "the finest saw-toothlets." Strong (1902, fig. 25, pl. 5) has represented them in his figure of a curved fiber. These processes of the curved fibers seem to correspond to and be homologous with the hooks of the hook-fibers. They are most highly developed in *Diomedea* where they are extremely narrow and terminate in long, fine points. In this region, where on the dorsal margin the teeth, and on the ventral the processes appear, the curved fiber is already considerably narrowed and it continues to grow narrower distally till it finally terminates in a long, fine thread (fig. 28, *F*). The point of transition of the band-shaped proximal portion into this terminal thread coincides with the completion of the bend. The ventral processes take no part in this bend and retain the direction of the basal part of the fiber unchanged.

We will now consider again the series of transverse sections. We have seen that in the proximal parts the upper margin of the fibers is involuted spirally and that the curvature decreases toward the lower margin, the concave band gradually unrolling itself, as it were, toward the latter. Toward the middle of the length of the fiber there is a change. The portion of the transverse section lying midway between the upper and the lower margins, which before was considerably curved first flattens itself out and then forms an obtuse angle the reverse way, so that here the section attains the shape of a 3 (fig. 27, *X*). At the same time the whole fiber is spirally twisted so that the axis of the transverse section assumes first a vertical position and then inclines above toward the secondary quill.

The distal termination of the curved fibers is very similar to the long, thin terminal thread of such hook-fibers as those of the Caprimulgi. While in most cases the thread in which the curved fiber terminates appears as a simple filament without any differentiation, sometimes slight thickenings appear in it at about equal distances, which apparently correspond to the nuclei of the cells arranged one behind the other, which compose this portion of the fiber (fig. 27, *V*). The terminal threads of the successive curved fibers are parallel with each other and lie close together (figs. 19, 21).

The curved fibers spring from that side of the secondary quill which is turned toward the feather base. Their points of origin lie lower than those of the hook-fibers (figs. 3, 4).

In length the curved fibers surpass the hook-fibers, particularly in

the terminal threads of the former which are always longer than those of the latter in the same part of the feather. In *Nyctea nivea,* for instance, the proximal portion of the hook-fibers is on an average only 300 to 350 μ, those of the curved fibers, 900 μ long. The shape of the curved fibers is very constant. With the exception of a few isolated cases, such as *Diomedea,* in which the ventral membranous processes display a peculiar structure, they are entirely similar in all birds, differing only in respect to their size, which is proportional to that of the whole feather. The number of the curved fibers is somewhat less than that of the hook-fibers. The reason for this is that they are 30 to 40 μ apart, which is a little greater than the distance between the hook-fibers.

6. *The Formation of the Feather-Plate*

The two kinds of tertiary fibers described above together form the greater part of the plate represented by the feather. As Schroeder (1880, p. 3) tells us in the historical part of his work, Marcellus Malpighi, the first investigator who occupied himself with the study of the feather, could only speak of an interweaving (implicatio) of its smaller elements. Subsequent investigators declared that these elements were too small for exact study. Nitzsch (1840, pp. 14, 15) was the first to try to solve the problem. He pointed out that the hooks of the upper "rays" (hook-fibers) were designed to grip the lower fibers. This they do by inserting themselves into small depressions in the sides of the latter. These "depressions" of Nitzsch's are however not depressions at all but the nuclei of the cells composing the curved fibers. Burmeister in a note pointed out this error (Nitzsch, 1840, p. 15), and stated that the hooks were too short to reach these "depressions" of the curved fibers. According to him the hooks are intended to grip the upper margin of these fibers, which he considers thickened and which he says they just reach and actually grasp. Schroeder (1880, p. 10), and Klee (1880, p. 18) discovered that the upper margin of the lower (curved) fibers is not thickened, as Burmeister had thought, but involuted to form a groove, which makes the impression of a thickened edge in surface views of the feather magnified with the microscope. This involuted margin is grasped by the hooks of the hook-fibers, which can glide backward and forward beneath it without relaxing their grip. Wray (1887, p. 422) and Ahlborn (1896, p. 20) also describe the formation of the feather-plate. According to them the hooks of the hook-fibers penetrate into the layer of underlying curved fibers and take hold of the membranous ventral

processes of the latter. The incorrectness of this statement can easily be demonstrated by the examination of a surface view by which it is to be seen that in their natural position the hooks lie some distance beyond the zone of these ventral processes and in reality grasp the more proximal, band-like portions of the curved fibers. They are moreover too short to reach as far down as the ventral margins of the curved fibers from which these processes protrude horizontally. Finally, one must consider that if the hooks actually gripped these processes they would not be capable of gliding backward and forward, but would be wedged in firmly between them. According to my own observations the hook-fibers overlie the curved fibers and cross them at an angle of nearly 90° (figs. 17, 18, 19). The hooks hanging down cling by their lower margin to the involuted upper margin of the curved fibers. All the hooks of one hook-fiber hold different curved fibers (figs. 24, 25), so that as many curved fibers are held by one hook-fiber and as many hooks grip each curved fiber as there are hooks on each hook-fiber. The hooks can glide backward and forward in the smooth groove of the upper margin of the curved fiber, a fact which is of great importance in flight. During each downward wing stroke a pressure is exercised on the lower side of the feather-plate. As Parseval (1880, p. 70) asserts, the angles between the secondary and the primary quills grow more obtuse under the action of this pressure, and the distance between the outer part of the secondary quills increases. At the same time the feather changes its curvature and its surface increases. These changes are made possible by the gliding of the hooks which connect the two systems of tertiary fibers. If the secondary quills move apart, the hooks glide from the middle of the ribbon-like portion of the curved fibers which they clasp during rest, towards their distal end (fig. 19. See the direction of the arrow). If the pressure were still increased the hooks would glide still further and slip off the curved fibers, thus losing their hold altogether if it were not for the peculiar arrangement for arresting them, which effectually prevents this. The bending of the curved fiber itself resists such a slipping off and the dentate protuberances of this part of their upper margin (fig. 28, *zf*) described above, make it still more difficult. These teeth being directed backward it becomes easy at the same time for the hooks to glide back into their proper position, should they have been carried beyond by some unusual force.

III. Summary of Results

1. In the core of the secondary quills the cells may be so arranged as to form several irregular, or one single regular layer. The first type is the more frequent. The second is met with chiefly in the Striges and Caprimulgi.

2. All secondary quills have a ventral hornridge. It varies between a low crest (*Cypselus, Columba*) and a large, curved, membranous plate (*Diomedea, Striges, Cygnus*).

3. The degree of concavity of the secondary quill is correlated to the size of the central hornridge.

4. At the origin of the tertiary fibers from the secondary quills very complicated structures are met with. Here a projecting longitudinal ledge occurs from the upper side of which oblique crests protrude, parallel and close together like the bars of a gridiron. Between these crests lie the proximal portions of the tertiary fibers.

5. The diminution in height of the secondary quills from the main quill outward may be gradual, constant and moderate, or interrupted by a step, as in *Striges* and *Cygnus*.

6. The height of the secondary quills is greatest either at the feather base (*Aquila, Diomedea*) or more frequently above the middle of the length of the feather (*Cygnus, Bubo, Macropteryx*).

7. The teeth of the outer feather-vanes of the first three remiges of the owls are peculiarly differentiated tips of secondary quills.

8. The hook-fibers always spring from the inner side of the secondary quill which is turned toward the main quill and the feather-tip. They are transversely curved bands composed of a single row of cells. These cells may possess projections which are, proximally, dorsal lobes and ventral hooks; distally, dorsal and ventral spines.

9. The number of hooks on each hook-fiber is 2 to 8; it is constant in the same species.

10. Peculiarly shaped hook-fibers are found in the Striges and Caprimulgi. In the former they are very long and provided with numerous large spines; in the latter likewise they are long, but have no distal spines.

11. The distance between the hook-fibers in the functional remiges of all classes of birds varies only between 20 and 30 μ.

12. The curved fibers spring from the outer side of the secondary quill which is turned away from the primary quill and toward the feather basis. They are transversely curved bands, like the hook-fibers which they resemble in many points.

13. The dorsal, dentate projections at the bend of the curved fibers are an arresting apparatus.

14. The distance between the curved fibers in the functional remiges of all classes of birds varies only between 30 and 40 μ.

15. The powerful development of the ventral hornridge of the secondary quills in *Diomedea* and *Aquila* is doubtless functionally related to the sailing flight of these birds.

16. The teeth on the outer vane of the first hand remiges in the Striges and Caprimulgi, and the down on the upper surface of the remiges of these birds formed by the lengthened, distal portions of the hook-fibers deaden the sound of the flight of these night birds.

IV. List of Authors Consulted and Quoted

Ahlborn, F.

1896 Zur Mechanik des Vogelfluges. Hamburg, 1896.

Beddard, F. E.

1898 The Structure and Classification of Birds. London, 1898.

Clark, H. L.

1894 The Pterylography of certain American Goatsuckers and Owls. Proc. U. S. Nat. Mus., v, 17, pp. 551–572.

Clement, C.

1876 Note sur la Structure microscopique des Plumes. Bull. Soc. Zool. France, I, 1876, pp. 282–286.

Cuvier, G.

1809 Leçons d'Anatomie comparée. Recuillées et publiées par C. Dumeril, T. II, p. 603 (cf. Mem. d. Mus., 13, 330).

Davies, H. R.

1889 Die Entwickelung der Feder und ihre Beziehung zu anderen Integumentbildungen. Morph. Jahrb., Bd. 15, pp. 560–645, Taf. 23–26.

de Meijere, J. C. H.

1895 Ueber die Federn der Vögel, insbesondere über ihre Anordnung. Morph. Jahrb., Bd. 22, pp. 562–591.

Fatio, V.

1886 Des diverses modifications dans les formes et la coloration des plumes. Mem. Soc. Phys. et Hist. Nat. Genève, T. 18, Part 2, pp. 249–308. 3 pls.

Gadow, H.

1882 On the color of Feathers as affected by their Structure. Proc. Zool. Soc., London, pp. 409–421, Pl. 27, 28.

Haecker, V.

1890 Ueber die Farbe der Vogelfedern. Arch f. mikr. Anat., Bd. 35, Hft. I, pp. 68–87, Taf. 4.

Haecker, V., und Meyer, G.

1901 Die blaue Farbe der Vogelfeder. Zool. Jahrb., Abth. Syst. Geog. und Biol. d. Tiere, Bd. 15, Hft. 2, pp. 267–294, Taf. 14.

Heusinger, C. F.

1882 System der Histologie. Bd. 2, p. 207.

Holland, Th.

1868 Pterologische Untersuchungen. Cabanis, Journal f. Ornith., Jhg. 12, pp. 195-217.

Klee, R.

1886 Bau und Entwickelung der Feder. Haller'sche Zeitschrift f. Naturw., Bd. 19 (N. F., Bd. 12), Hft. 1, pp. 174-327.

Mascha, E.

1902 Der Bau der Flügelfeder. Verh. Ges. D. Naturf. u. Aerzte, 74, Vers. 2, Th. 1, H, pp. 159-162.

Nitzsch, Ch. L.

1840 System der Pterylographie. Herausgegeben von H. Burmeister, Halle, 1840, 10 Taf.

Parseval, A. von.

1889 Die Mechanik des Vogelfluges. Wiesbaden, 1889.

Schroeder, R.

1880 Pterographische Untersuchungen. Diss. Inaug., Halle, 1880.

Strasser, H.

1885 Ueber den Flug der Vögel. Jenaische Zeitschr. f. Naturw., Bd. 19 (N. F., Bd. 12), Hft. 1, pp. 174-327.

Strong, R. M.

1902 The development of color in the Definitive Feather. Bull. Mus. Comp. Zool., v, 40, pp. 147-185. Pl. 9.

Sundeval, C. J.

1843 Om Foglarnes vingar. K. V. Akad. Handlingar, 1843, Isis, v. Oken, Hft. 5, 1846.

Wray, R. S.

1887 On the Structure of Barbs, Barbules and Barbicels of a typical pennaceous Feather. Ibis, 1887, pp. 420-423, Pl. XII.

EXPLANATION OF FIGURES.

1. Three transverse sections of a secondary quill of *Columba livia.* *a* at the base close to the primary quill; *b* in the middle; *c* at the tip on the outer edge of the broad feather vane. Magnified 1:100.

2. Three transverse sections of a secondary quill of *Caprimulgus europaeus.* *a* at the base close to the primary quill; *b* in the middle; *c* at the tip near the outer margin of the broad feather vane. Magnified 1:100.

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8. Hook-fiber of *Columba livia.* Magnified 1:220.

9. Hook-fiber of *Diomedea exulans.* Magnified 1:125.

10. Hook-fiber of *Columba livia.* Magnified 1:125.

11. Hook-fiber of *Cypselus apus.* Magnified 1:125.

12. Hook-fiber of *Nyctea nivea.* Magnified 1:125.

13. Hook-fiber of *Podargus humeralis.* Magnified 1:100.

14. Hook-bearing part of a hook-fiber of *Turacus albocristatus,* showing the spines of the proximal hooks. Magnified 1:480.

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16. Proximal portion of a hook-fiber of *Cypselus apus,* showing the cell boundaries and the swelling on the upper margin. Magnified 1:400.

17, 18, 19. Surface views of the upper side of a hand-remex of *Cypselus apus,* focussed at three different levels. Magnified 1:270.

17. Highest level showing the terminal threads of the hook-fibers.

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20. The points of origin of the hook-fiber in a hand-remex of *Columba livia,* seen from above. Magnified 1:400.

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24, 25. Schematic representation of the connection of the hook and curved fibers.

24. Section parallel to the curved fibers.

25. Section parallel to the hook-fibers.

26. Section of a hand-remex of *Columba livia,* parallel to the curved fibers. Magnified 1:225.

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30. Outer vane of the ninth hand-remex of *Podargus humeralis,* showing the dentate margin. Magnified 1:2.

31. Outer vane of the ninth hand-remex of *Bubo maximus,* showing the dentate margin. Magnified 1:2.

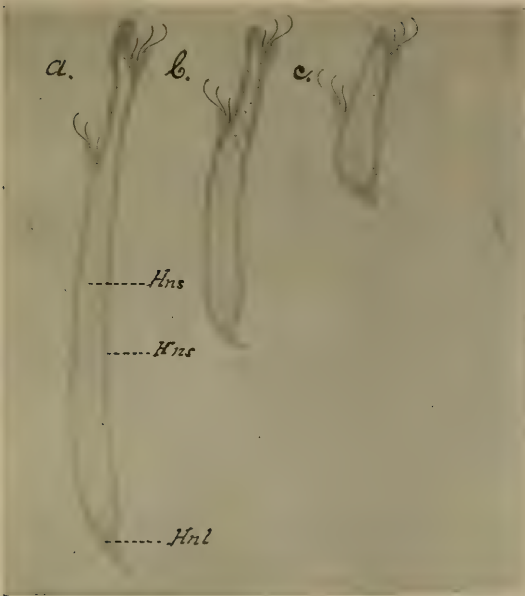
32. Section through the outer portion of the broad feather vane in a hand-remex parallel to the curved fibers of *Bubo maximus,* showing the down on the upper side. Magnified 1:12.

33. Section through the middle of a hand-remex of *Bubo maximus,* perpendicular to the secondary quills. Magnified 1:7.

34. The teeth of the margin of the outer feather vane of the tenth hand-remex of *Bubo magellanicus.* Magnified 1:70.

Key to Lettering, which applies to all Figures.

Bgf. Curved fibers.
F. Terminal thread.
G. Ledge below the point of origin of the tertiary fibers.
H. Hooks of the hook-fibers.
Hkf. Hook-fibers.
Hnl. Ventral hornridge of the secondary quill.
Hns. Horny substance.
Htk. Primary quill.
K. Nuclei of the cells forming the tertiary fibers.
L. Crests on the ledges of the secondary quills.
Mks. Medullary substance.
R. Groove in the upper margin of the curved fibers.
Vd. Dorsal thickening of the secondary quills.
vnL_1. Processes of the ventral membrane of the hook-fibers.
vnL_2. Processes of the ventral membrane of the curved fibers.
W_1. Spines of the hook-fibers.
W_2. Dorsal lobes of the hook-fibers.
Z. Teeth on the outer edge of remiges.
Zf. Dentate projections on the dorsal margin of the curved fibers.
Zgr. Limits of the cells composing the tertiary fibers.



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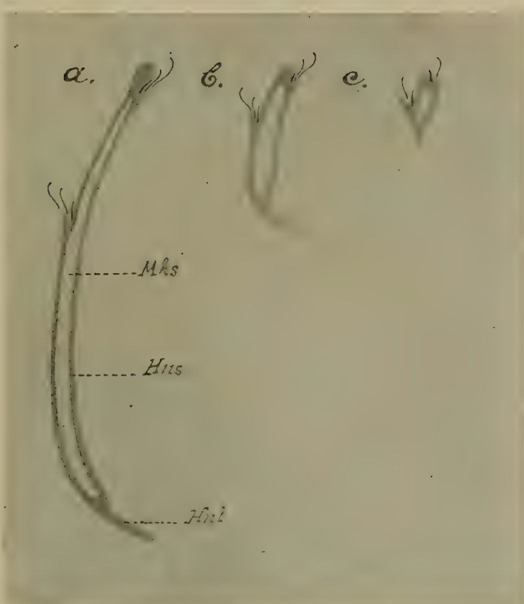

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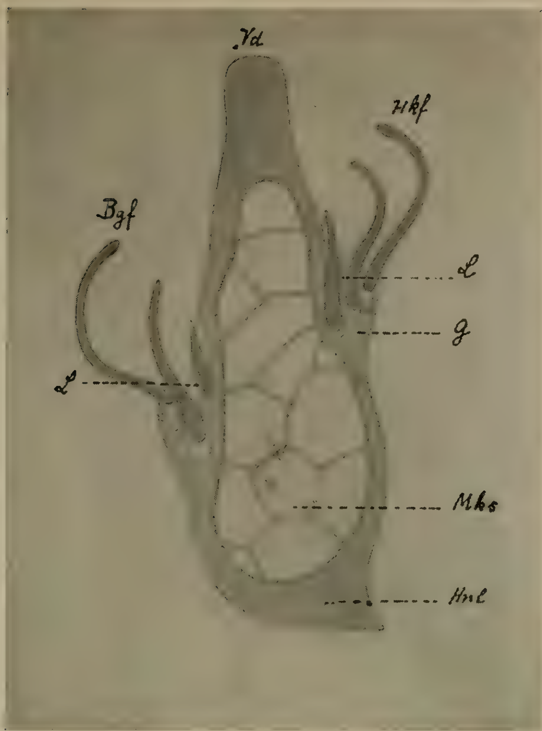

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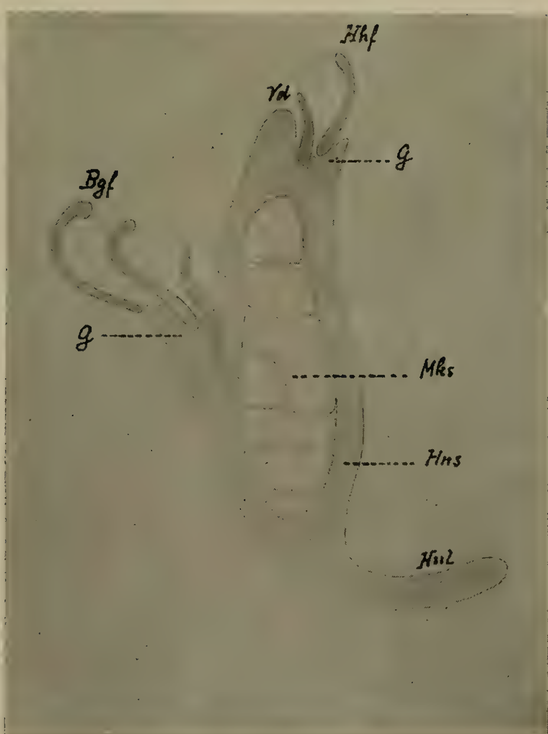

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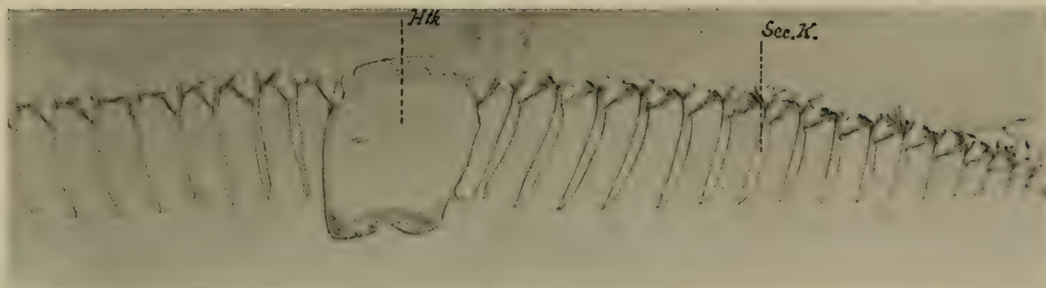

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5 Section through the feather vane vertical to the secondary quills; through the wing covert of *Garrulus glandarius*. Magnified 1:190
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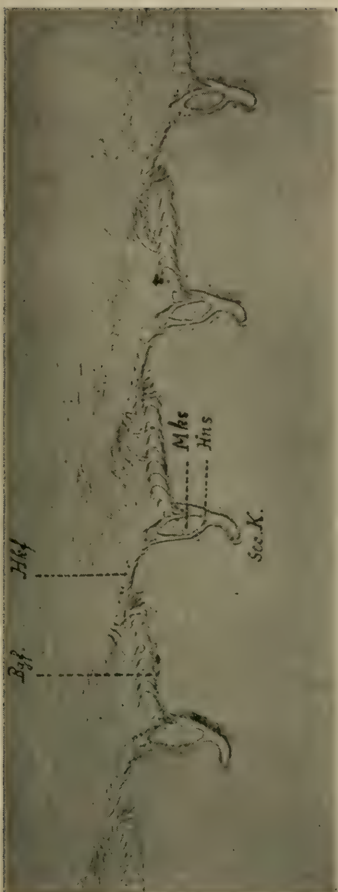

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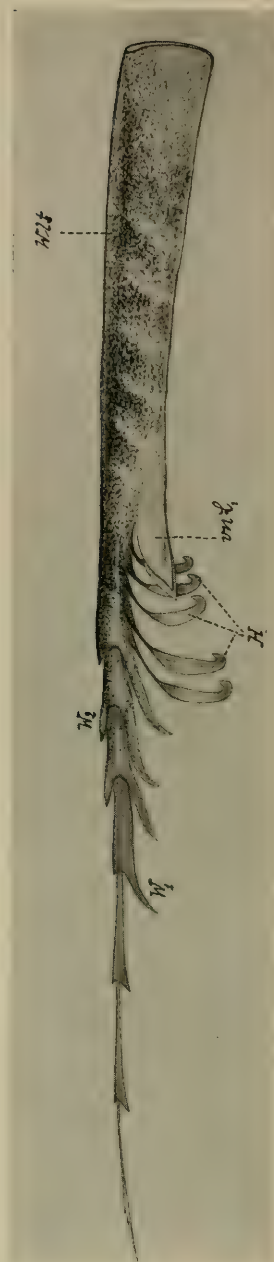

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7. Section through the proximal part of the broad vane of a hand-remex of *Caprimulgus europaeus* vertical to the secondary quills Magnified 1:80
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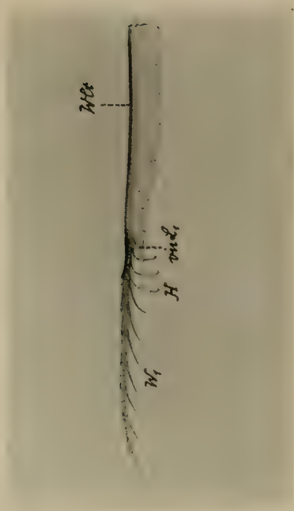

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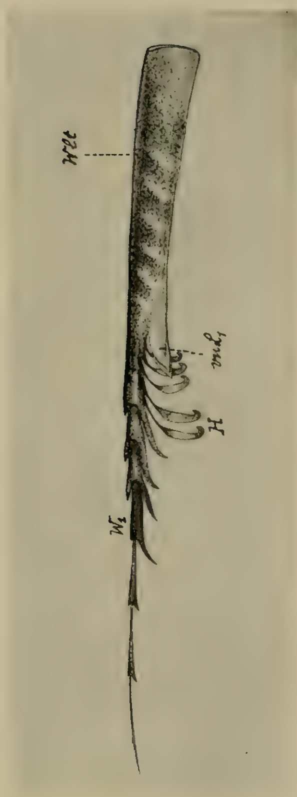

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9. Hook-fiber of *Diomedea exulans*. Magnified 1:125
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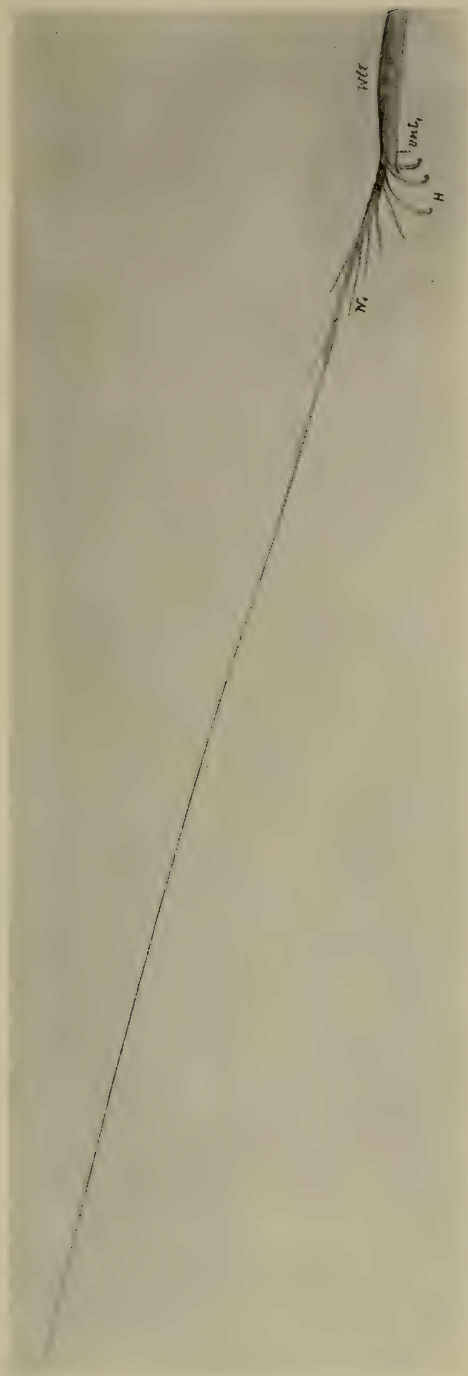

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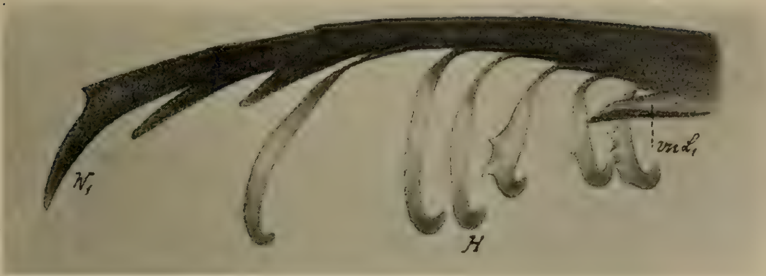

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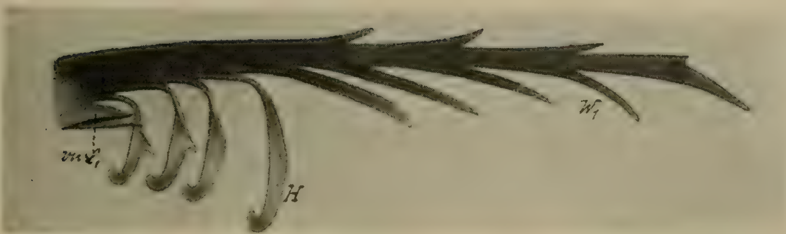

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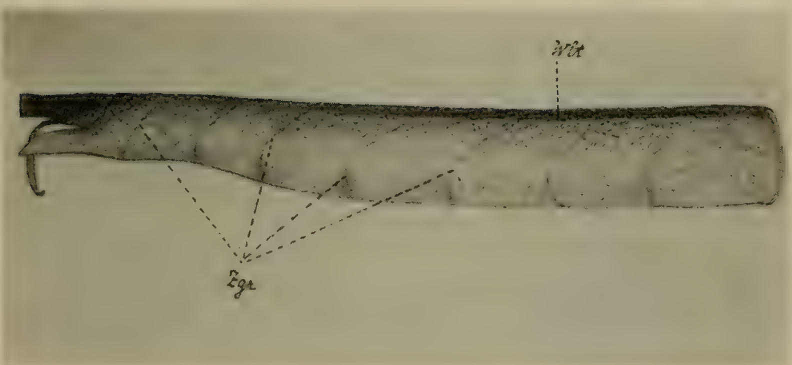

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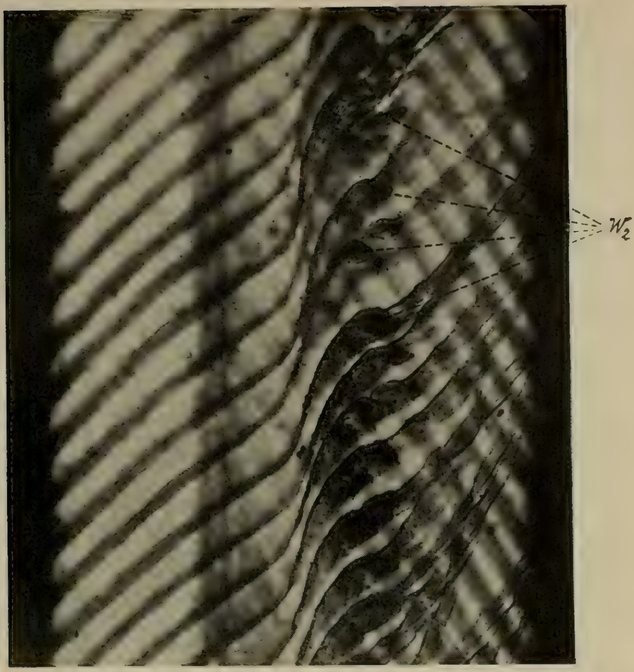

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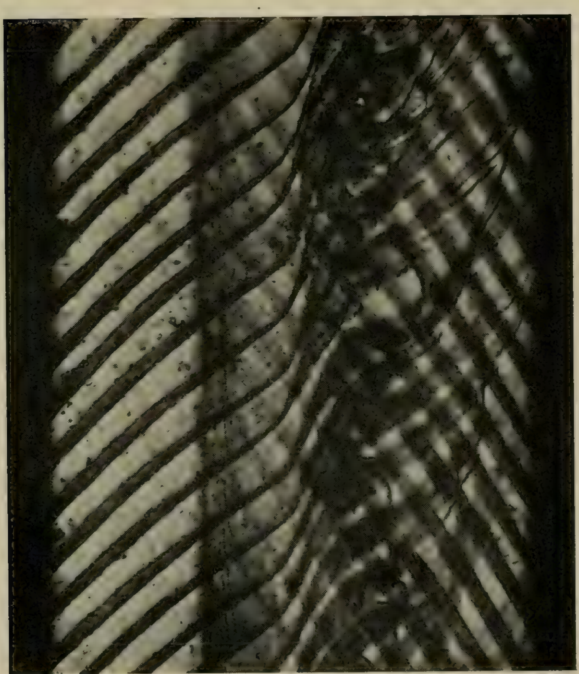

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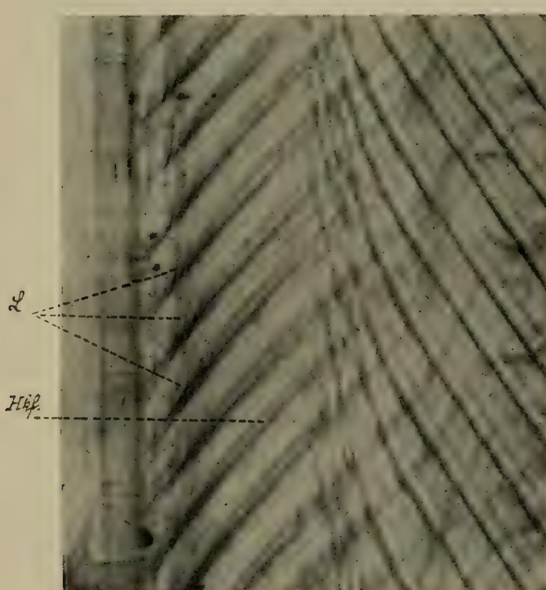

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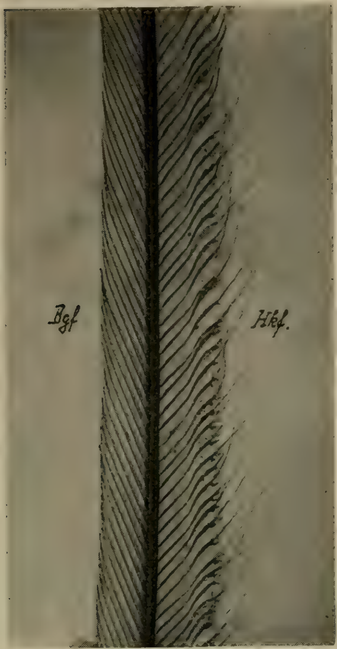
19. Lowest level showing the curved fibers

20. The points of origin of the hook-fiber in a hand-remex of *Columba livia,* seen from above. Magnified 1:400



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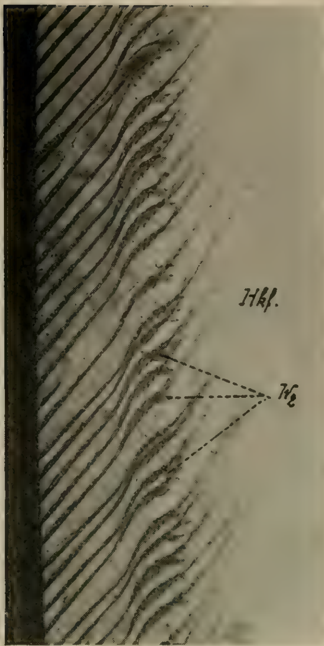

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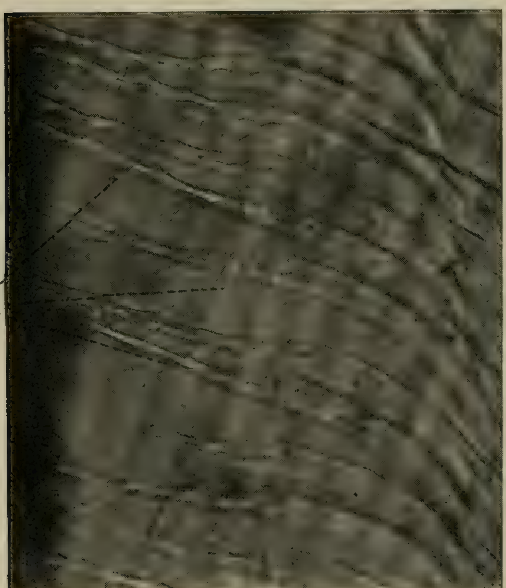

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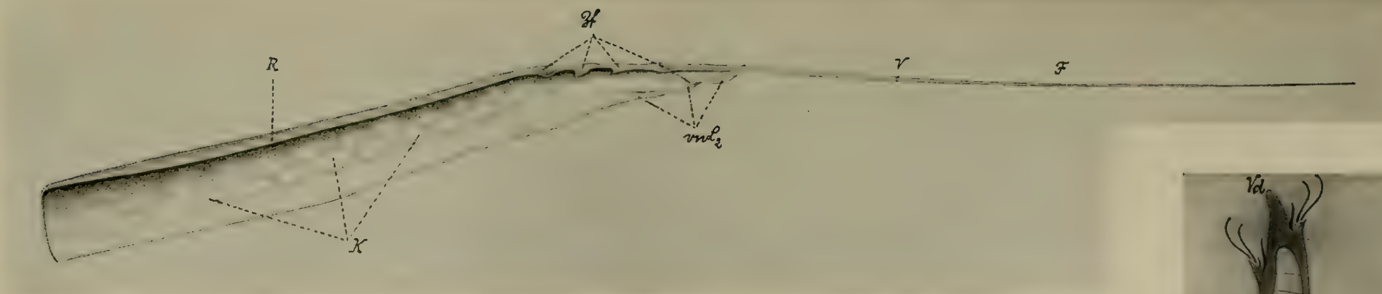

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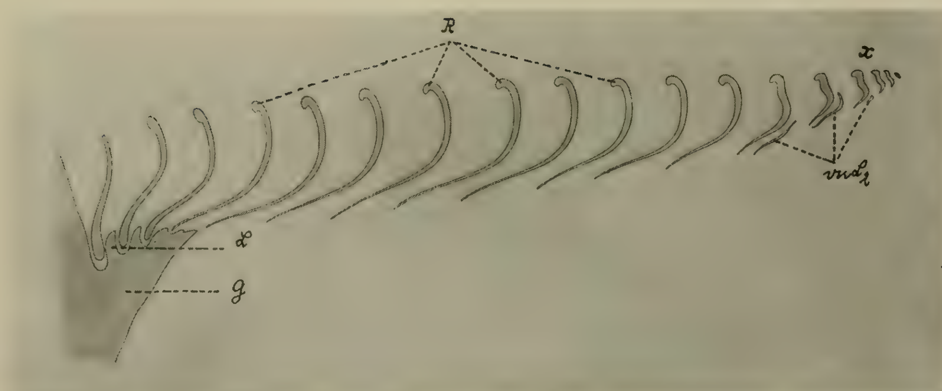

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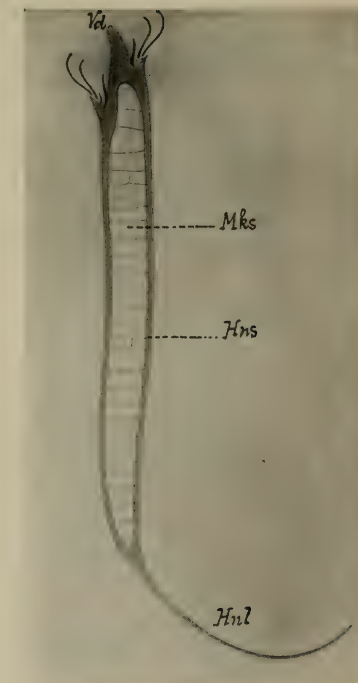

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27. Section of a hand-remex of *Columba livia*, parallel to the hook-fibers. Magnified 1:450
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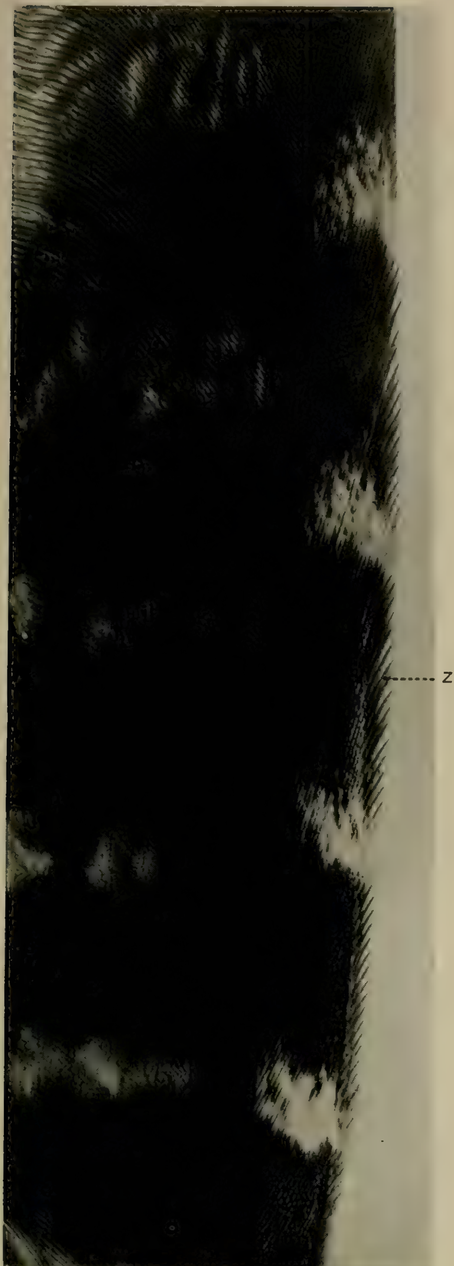

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34

34. The teeth of the margin of the outer feather vane of the tenth hand-remex of *Bubo magellanicus*. Magnified 1:70

THE TARPON AND LADY-FISH AND THEIR RELATIVES

By THEODORE GILL

Data respecting the habits of the tarpon and lady-fish are here brought together from widely distant sources and the little information at hand respecting the habits of their relative, the *Pterothrissus* of Japan, is added. The statements here collected, it is hoped, may serve as hints to observers respecting facts to be looked for in the biology of those fishes.

The morphological or rather chief osteological characteristics of the types here considered have been recently investigated and elucidated by Dr. W. G. Ridewood in a well illustrated article "On the Cranial Osteology of the Fishes of the Families Elopidæ and Albulidæ" published in the Proceedings of the Zoölogical Society of London for 1904 (vol. II, pp. 35–81). The illustrations are so good and so much to the point that they are here reproduced. They show well the distinctive characterers of the genera as well as the common characteristics which evince the relationship of the Elopids and Albulids and distinguish them from the Clupeids to which the former have so strong but illusive likeness.

The Tarpon and its Family

One of the most remarkable of the families of fishes is that of the Elopids, and of that family the tarpon of the Floridian waters is the most notable. Yet comparatively little is known of the habits of any of the species. Much—very much—has been written about the tarpon, but most of it has been of a personal or subjective nature and not about the fish itself. To elicit new facts and indicate desiderata is the object of the present article. What is known may be briefly summarized.

I

The family of the Elopids (Elopidæ) is composed of a few living fishes which have much superficial resemblance to the herring family; they have a compressed fusiform body, covered by smooth silvery cycloid scales; the head is bony and scaleless; the mouth and jaws nearly like those of Clupeids and more or less oblique; the dorsal is submedian and the other fins are essentially like those of the

herrings. The distinctive characteristics are the very numerous (22–30) branchiostegal rays, an unpaired gular plate or intergular plate or bone (also called "jugular plate") between the rami of the lower jaw, and the development of the parietal bones so that they connect along the middle of the skull and consequently superficially separate the frontal bones from the supraoccipital; the supramaxil-

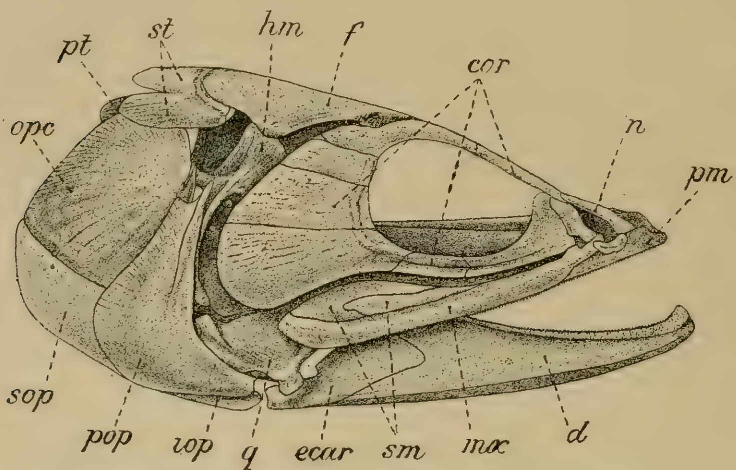


FIG. 1.—*Elops saurus;* skull from right side. (After Ridewood.)

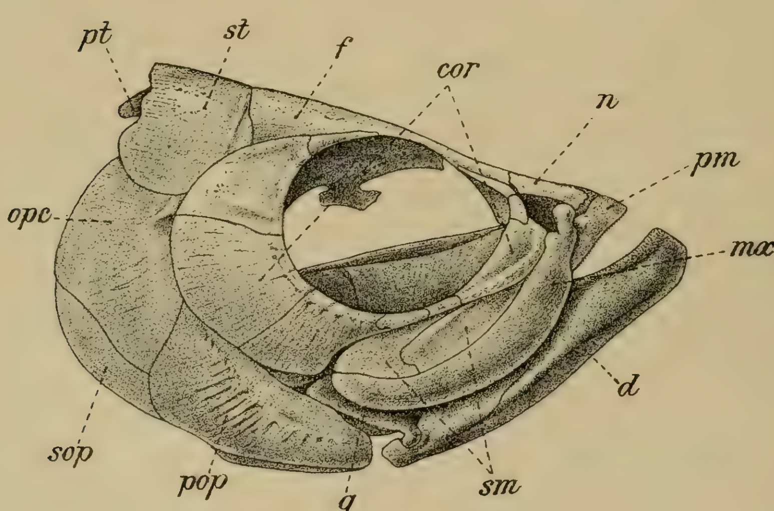


FIG. 2.—*Megalops cyprinoides;* skull from right side.

Figs. 1 and 2.—Elopoid skulls showing trend of mouth, composition of supramaxillaries (*sm.*), shape of circumorbital bones (*cor.*), etc. (After Ridewood.)

laries are very large, each composed of three pieces, and mostly outside of but adjoining the suborbitals (*cor*); the circumorbitals are peculiarly modified, there being a well developed preorbital, followed by a narrow suborbital, above the supramaxillary, and then by broad ones beginning above the hinder portion of the supramaxillary and continued back of the orbits. The parasphenoid bone is narrow.

The family of the Elopids, like that of the Chirocentrids, is a decadent one—one of the past rather than of the present. It was represented by numerous genera and still more numerous species during the Cretaceous epoch. Some of those were of large size, even exceeding the recent tarpon in dimensions, and almost all of them became extinct by the end of that period. The family was far less conspicuous during the Tertiary epoch, but as early as the Lower Eocene the still existing generic types *Elops* and *Megalops* made their appearance. At least remains of fishes found in the London Clay have been referred to these genera by A. Smith Woodward. Their later tertiary history is unknown.

The living species are few in number—only four—and belong to two very distinct groups which are usually considered the only genera—*Elops* and *Megalops*. These are distinguishable by a number of important characters.

II

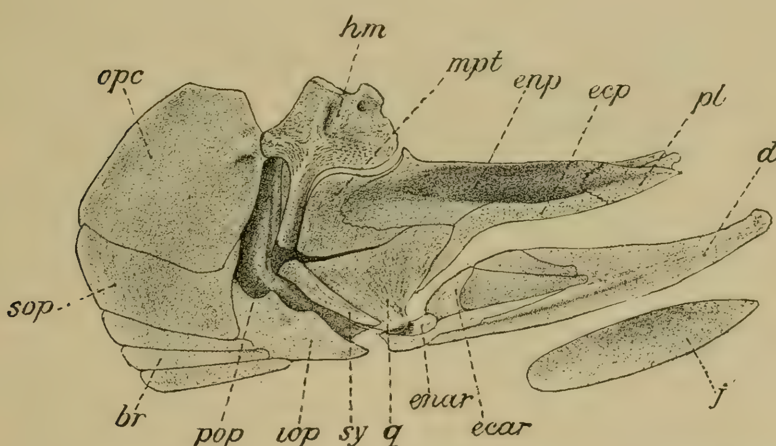


FIG. 3.—*Elops saurus;* hyopalatine arch, opercular bones, etc., with mandible; left side, mesial aspect. *j*, jugular plate, dorsal view. (After Ridewood.)

Elops, the genus which has given name to the family, has small scales, a small head, lower jaw not projecting, pseudobranchiæ

large, an oblong dorsal fin with the last ray not produced, and the anal fin small. Further, the head is slender and pike-like, the mouth not very oblique, the lower jaw especially slender and its articulation far behind, under the postorbitals, and the suspensorium angular, the hyomandibular being inclined backwards. It contains two species, the long known and wide-ranging *Elops saurus*, and the localized *Elops lacerta* of the Congo and western Africa.

The *Elops saurus* is common in the open sea along the coast of the southern United States and is best known as the ten-pounder, though it has received many other names.

The accepted name was current at least as early as the seventeenth century for Dampier, in his "Voyages to the Bay of Campeachy," for 1676 records (p. 71) "ten-pounders" among the fishes (including tarpons, parricootas, etc.) he found in "the lagunes, creeks and rivers." "Ten-pounders," he adds, "are shaped like mullets, but are so full of very small stiff bones, intermixt with the flesh that you can hardly eat them."

The species needs no further attention for the present at least.

III

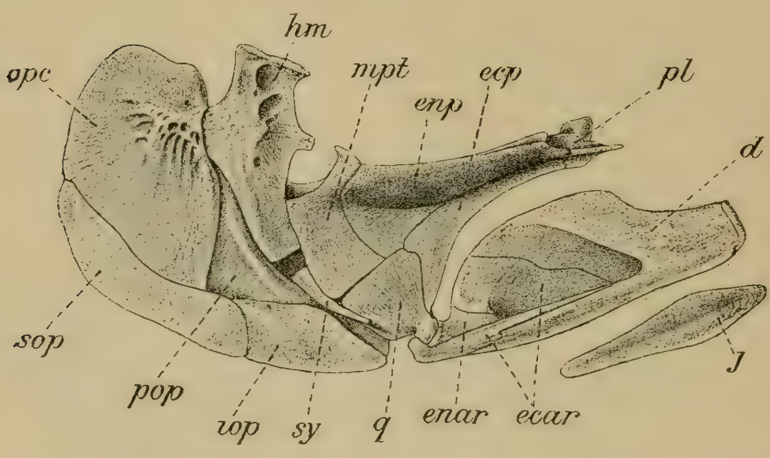


FIG. 4.—*Megalops cyprinoides*; hyopalatine arch, opercular bones, and mandible of left side, mesial aspect. *j*, jugular plate, dorsal view. (After Ridewood.)

The genus *Megalops* has very large scales (30 or more along the lateral line), the head is comparatively large and the lower jaw projecting; there are no pseudobranchiæ; the dorsal fin is inserted more or less behind the ventrals and its last ray is produced into an elongated "filament." In contrast also with *Elops* the head is short

and oblong by reason of the very oblique mouth, the lower jaw is abbreviated, truncated in front, and with the articular fossæ under the eyes, and the suspensoria are each continuous, the hyomandibulars being inclined forwards.

Two very distinct forms are known—so distinct indeed that they have been referred to different genera—the *Megalops cyprinoides* of the Indian Ocean and northern Australia and the *Megalops atlanticus* or celebrated tarpon of America.

The tarpon (*Megalops atlanticus*) has an elongated fusiform shape; the forehead slightly incurved (rather than straight) to the snout; the chin projects and is obliquely truncated; the dorsal (with twelve rays) is on the posterior half of the body, nearly midway between the ventrals and anal; its free margin is very sloping and incurved and its long hind ray reaches nearly to the vertical of the anal; the anal (with twenty rays) is about twice as long as the dorsal and falciform; the caudal fin has a very wide V-shaped emargination. The scales are in about forty-two oblique rows. It reaches a length of about six feet—sometimes more.

IV

The oldest form of the name seems to have been *Tarpon;* such is the guise it has in Dampier's "Voyages to the Bay of Campeachy" in 1675, and in Roman's "Concise Natural History of Florida" (1775). Dampier found that "the fish which they take near the shore with their nets are snooks, dog-fish and sometimes tarpon. The tarpon," he says, "is a large scaly fish, shaped much like a salmon, but somewhat flatter. 'Tis of a dull silver color, with scales as big as a half crown. A large *tarpon* will weight 25 or 30 pounds. 'Tis good, sweet, wholesome meat, and the flesh solid and firm. In its belly you shall find two large scallops of fat, weighing two or three pounds each. I never," continues Dampier, "knew any taken with hook or line; but are either with nets, or by striking them with harpoons, at which the Moskito-men are very expert." Such are the ideas of the fish gained by Dampier in its southern resorts. How different they are from those now prevalent in the United States will appear hereafter.

The name in most general use is *tarpon* and this may be considered to be the literary and accepted phase. *Tarpum* was also an early form, but is now obsolete. Along the Texan coast *Savanilla* is still in general use, but is gradually being superseded by tarpon on account of the influence of anglers. The apt descriptive name *Grande-écaille* (pronounced grandykye and meaning large-scale) was

given by the French settlers of Louisiana. Other names of still more limited use are *silver-fish* (Pensacola), and *jewfish* (Georgia and parts of Florida). Jewfish it shares with many other fishes, and another fish of Florida, a gigantic Serranid, is better known by the term. *Silver-king* is a euphemistic designation. *Caffum* is a name current in the island of Barbados.

V

The tarpon may be briefly defined as a littoral fish of warm American seas often entering into rivers and acclimated in some inland lakes.

The boating excursionist along some favored shore of Florida or Texas during the spring and summer months at least—perhaps during all but the winter months—may be startled by the sudden projection from the water of a silver-like mass, which, after describing a low arch, will splash into the water again at a distance of maybe twenty feet from the starting point; that mass is the tarpon, or the "silver king." Florida and Texas are the states in whose waters the fish is most freqently seen, because there most looked for, but its range extends far beyond those coasts in all directions. In summer wanderers visit the north as far as Massachusetts, where large individuals of the "big-scale fish," as they are there called, are "taken every year in traps at South Dartmouth" in the "latter part of September"; southward they may be found in Brazil and sporadically in Argentina. Around all the islands of and in the Caribbean Sea and Gulf of Mexico schools may be met with. Further, immigrants have found their way into rivers that enter into the tropical seas and the Lake of Nicaragua has long been famous as the home of the species.

Being essentially a warm water fish, it is only in the warm months that the tarpon is to be found at its northern and southern limits. On the approach of cold weather it retires towards the tropics. Along the southern Floridian coasts some "appear in February, increasing rapidly in numbers in March, April and May"; in Texas, "early in March." At first they refuse the bait but "during the latter part of May and in June" bite freely. "About the first of December" they "disappear entirely" from the Texan waters. In the tropical seas they may be found always, and about Tampico, in Mexico, their "season is from November first to April, the time when the tarpon practically disappears from Florida and Texas."

The tarpon is sensitive to sudden changes of temperature and especially to cold, and to such changes it is sometimes subject in

its northern range. During a cold wave which invaded Florida towards the end of January (26–27) 1905, according to a letter of E. J. Brown in "Forest and Stream," "the tarpon especially were affected by the cold." There were brought to "Lemon City between forty and fifty tarpon which had been so benumbed by the cold as to be easily speared by parties who were searching for them. The largest fish was in length seven feet one and three-quarters inches, girth thirty-nine and three-quarters inches, weight one hundred and ninety-four pounds. Several others were nearly this size. . . . The tarpon were salted, to be sent to Key West market, where there is a ready demand for them."

VI

That the tarpon is a most active fish may be inferred from its form which is especially adapted for swift and enduring action. Its life is spent in the enjoyment of its power and in pursuit of food; a carnivorous fish, it preys "eagerly upon schools of young fry, or any small fish that it is able to receive into its mouth, and in pursuit of which it ascends fresh-water rivers quite a long distance." The schools of mullets contribute largely to the great fish's supply. Such it attacks by darting upon them and generally seizing them tail foremost. Its frequent leaps into the air, like those of the salmon, seem to be mostly in sportive manifestation of its intense vitality and not for food or entirely from fear. C. F. Holder tells that one leaping tarpon "fell headlong" into a "boat, passing through the bottom"; that another leaped over man and boat; and that still another sprung up to the "deck of a steamer" and "fell headlong into a passenger's lap." Other wonderful tales are told of the activity of the tarpon. According to Holder (at second hand from another), a fish made an "initial leap of twelve feet" and followed this up "with six leaps all equally high." The same observer believed that "the ordinary height a tarpon leaps is from seven to eight feet." While leaping, its gill-covers are frequently spread out and its blood-red gills visible. Withal it sometimes goes into very shallow water and seeks out a quiet nook in which it may rest, "perfectly stationary," for quite a long time.

VII

The life history is very imperfectly known, but it does not appear to breed at any place along the continental coast of the United States, for none except large individuals have been recorded from those places most resorted to by anglers. For a very long time one of thirty pounds weight was the smallest obtained in Florida and

one of eleven pounds in Texas. It apparently demands a temperature and conditions which the reef-forming coral animals require and sheltered brackish or fresh water for oviposition. In such localities about Porto Rico, in February, 1899, Evermann and Marsh found not eggs, but very young, and there "it evidently breeds." Thirteen fry, "2.25 to 3.25 inches" long, were collected at Fajardo; at Hucares, "in the corner of a mangrove swamp" in "a small brackish pool of dark-colored water," "entirely separated from the ocean by a narrow strip of land, four from 7.5 to 11.5 inches long were seined." The smallest previously known was about nine inches long. All these are probably the young of the first year.

The very young or larvæ will doubtless be found to be, like those of *Elops* and *Albula,* elongate ribbon-like animals of translucent and colorless texture, with a very small head and small fins. They are probably so transparent that their eyes alone are apparent in the water unless a very close examination is made. The youngest of the specimens (2.25 inches long) observed by Evermann and Marsh, were probably not long before developed from the larval condition. Such are the little fishes to be looked for as the very young of the great tarpon.

Most of the large tarpons caught along the coasts of Florida and the Southern states have attained full maturity; of such the length is about six feet, and the weight approximates one hundred pounds; they are probably nearly or over three years old. Growth, however, is continued in some much beyond the average, one of three hundred and eighty three pounds, it is claimed, having been harpooned.

VIII

"The silver-king is the greatest of game fishes." So declare Evermann and Marsh, and they echo the belief of many. Volumes and countless articles in periodicals have been devoted to detail of its excellencies. Its activity and gameness are proportioned to its size. The northern salmon affords tame sport compared with the "silver-king." Those of the average full-grown size (six feet long and one hundred pounds in weight) are caught in numbers with the rod and line; one weighing two hundred and twenty-three pounds closes for the time the record of feats with the rod, and it took the captor "three hours and a half before it was brought to gaff."

The tarpon is now considered to have little or no edible value. It has, indeed, been declared by Schomburgk to be "considered a delicate eating" in Barbados, and in the United States has been experimented with occasionally; one (W. H. Burrall) who did so in

1874, declared (in Forest and Stream, II, p. 324) that it was very palatable, but his taste was exceptional. It has been frequently tried since but rejected for the table. An effort was made on one or two occasions in Massachusetts when considerable numbers had been caught, "to find a market for them," as at New Bedford, "but the people did not like them, owing to the toughness of the flesh." Holder's negro oarsman aptly replied to the suggestion that it was "the finest looking fish in the world," "Yes, Sa, hit looks fine, so does hay. I'd rather eat hay dan tarpon, yes, Suh, I would." It is truly, as Holder remarks, almost the only great game fish "which is utterly scorned as a food fish." Dampier's opinion, expressed in 1675, and that of some Barbadians, has not been adopted by modern gourmands. It is "full of numerous small bones, which is a great inconvenience," says Schomburgk. In almost all cases where it has given anything like satisfaction the fish was of small size, and the truth may be that small ones are tender and savory but large ones coarse and tough, like overgrown individuals of other species. The results of unprejudiced judgment are still wanting.

It may be recalled here, however, that the Indian congener of the tarpon, the ox-eye (*Megalops cyprinoides*) is, according to Saville Kent as well as others, "highly esteemed for food," and in the Malay archipelago, where it likewise abounds, it is cultivated in tanks after the same manner as the milk-fish, *Chanos salmoneus*.

Far from being sought by the fisherman for the market, the tarpon is detested by him. "The Pensacola seine fishermen dread it while dragging their seines, for they have known of persons having been killed or severely wounded by its leaping against them from the seine in which it was enclosed. Even when it does not jump over the cork line of the seine, it is quite likely to break through the netting before landing." Nevertheless even a dead tarpon yields some compensation for the trouble he gives. There is quite a demand for its great beautifully silvered scales, some of which may be as large as a lady's palm. They find customers who are willing to pay as high as from five to twenty-five cents apiece and they are made up in various ways to attract the winter visitors to Florida.

IX

A species congeneric with the tarpon, but not very closely related, is the *Megalops cyprinoides* which, indeed, is the type of the genus. It is a less slender fish and the outline of the back and head is different from that of the tarpon; further, the dorsal fin is not so far backward, that fin and the anal have more rays (dorsal, 19 to 21;

anal, 24 to 27), and the proportions of all the fins are more or less different. The size, also, is never so great as in the giant tarpons, for it rarely, if ever, attains to a length of more than five feet.

Like the tarpon, the Asiatic fish readily accommodates itself to fresh water. According to H. S. Thomas (1897), in India "they acclimatize very readily to fresh water, and grow fast," and also breed, he was told, "in ponds." The natives, too, "are fond of keeping them in ponds."

They are more prone to associate in schools or shoals—that is, close together like herring—than the tarpon, especially when young. Thomas came "across them coming up an estuary in a shoal, and it was like hauling in mackerel; and they run about the same size. There was a fish on as fast as ever you could get your line in the water. But the fun was very short-lived. It was in mid-stream, and they were all past the boat in a very little time." Thomas took them "on a May fly and a Carnatic Carp fly." In "30 minutes," "on a light trout rod," he "took six of three-quarters of a pound each, lost four among weeds, and had one fly bitten off. Some of them sprang a foot in air, and all fought well."

The fame of the tarpon has, in recent years, been reflected on its eastern relative and the lesser species has found advocates for its pursuit as a game fish. "Enthusiastic anglers disposed to initiate" angling for it as for the American fish are referred by T. Saville Kent (1897) to the Badminton Magazine for 1895 for information. "There can be no doubt, in the writer's opinion," that the Australian fish, popularly known as the ox-eye herring, possesses "the most conspicuous potentialities for sport," and "would yield equally exciting sport on the same lines." Unlike its American relative, too, there might be the after satisfaction of seeing it on the table for, according to Kent, the ox-eye affords "most excellent eating." In India, it is raised to some extent for the table in tanks.

The Lady-Fish

The Albulids are unique in the development of two transverse rows of valves in the bulbus anteriosus in advance of the heart, in which respect there is an approximation to the Ganoids. The form and physiognomy are peculiar but there is more superficial resemblance to a whitefish (*Coregonus*) than to a herring; the body is fusiform but the dorsal arch much more curved forwards than the ventral; the scales are cycloid and brilliantly silvery; the head bony and scaleless, the snout prominent forwards; and the supramaxillaries are moderate, composed of only two pieces, and partly retractile

under the large preorbitals; the mouth is small and overhung by the prominent snout; the circumorbitals strongly contrast with those of the Elopids, a large horizontal preorbital being developed along

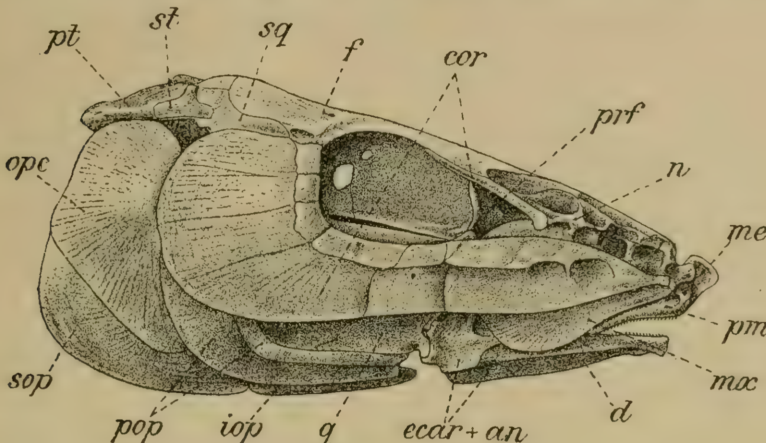


FIG. 5.—*Albula conorhynchus;* skull from right side. Showing the peculiar snout (*me.*), circumorbitals (*cor.*), etc. (After Ridewood.)

the side of the snout and this is followed by a short and equally wide suborbital, itself succeeded by wide, angular and postorbital bones, having a well defined sensory canal. According to Ridewood "there are in all twelve bones of" the circumorbital series. "The most anterior ones are curious, basket-like bones, not much wider than the sensory canals which they carry. The canals in this region are particularly large." There is no gular plate. The parasphenoid

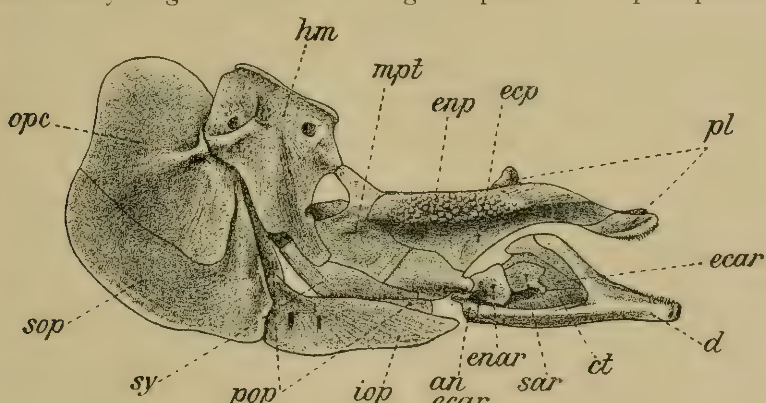


FIG. 6.—*Albula conorhynchus;* hyopalatine arch, opercular bones, and mandible, left side, mesial aspect. Showing the peculiar dental pavement of the entopterygoid bones, lower jaw, etc. (After Ridewood.)

bone is broad. Further the family is characterized by the villiform jaw and palatal teeth, pavement-like dentition of the hinder part of the mouth and wide parasphenoid bone.

I

The Albulids, like the Elopids, are an ancient family and representatives have existed from Cretaceous times to the present, although the affinities of the extinct forms have not been precisely determined. Remains of a fish that lived in the Lower and Middle Eocene and that was formerly called *Pisodus owenii* have been referred even to the genus *Albula*. In the present seas there is only one genus, *Albula*, represented by a single species, *Albula vulpes*.

It is found in almost every tropical sea, but it is not confined to such for individuals not a few extend their wanderings quite far beyond the tropical zone, occasionally even roaming northward to Massachusetts.

It attains a length of from a foot and a half to three feet and a weight of about three to ten pounds, but the average is far below the maximum mentioned.

II

Notwithstanding its wide geographical distribution, it is in truth a shore fish and seeks its food close to the shore or on muddy or sandy flats where shellfish—especially small bivalve shellfish—most abound. When the flood tide begins and "up to full tide" is the select time for feeding, and "flats in water varying from a depth of eight to ten inches," a choice place for hunting for food. As the fishes feed in such shallow water, their heads go down and their tails come out of the water, and as they work in shorewards their dorsal fins cut the water, and the sunlight is reflected from their silvery sides." The actions of the fish thus seen have suggested to some the name "grubber."

There is a beautiful correlation between the fish's food and the structural means for assimilating it. The dentition as a whole is quite peculiar—unlike that of any other animal. The bony roof of the mouth is closed in by the juxtaposition of the parasphenoid and pterygoid bones and covered with roundish molar teeth and the floor of the mouth has opposed teeth so that the fish is well provided with the means for crushing the shells which it takes; externally is provision for finding and rooting them up in the projecting conic snout, which is so prominent as to have suggested one of its early names—*Conorhynchus* or cone-snout.

III

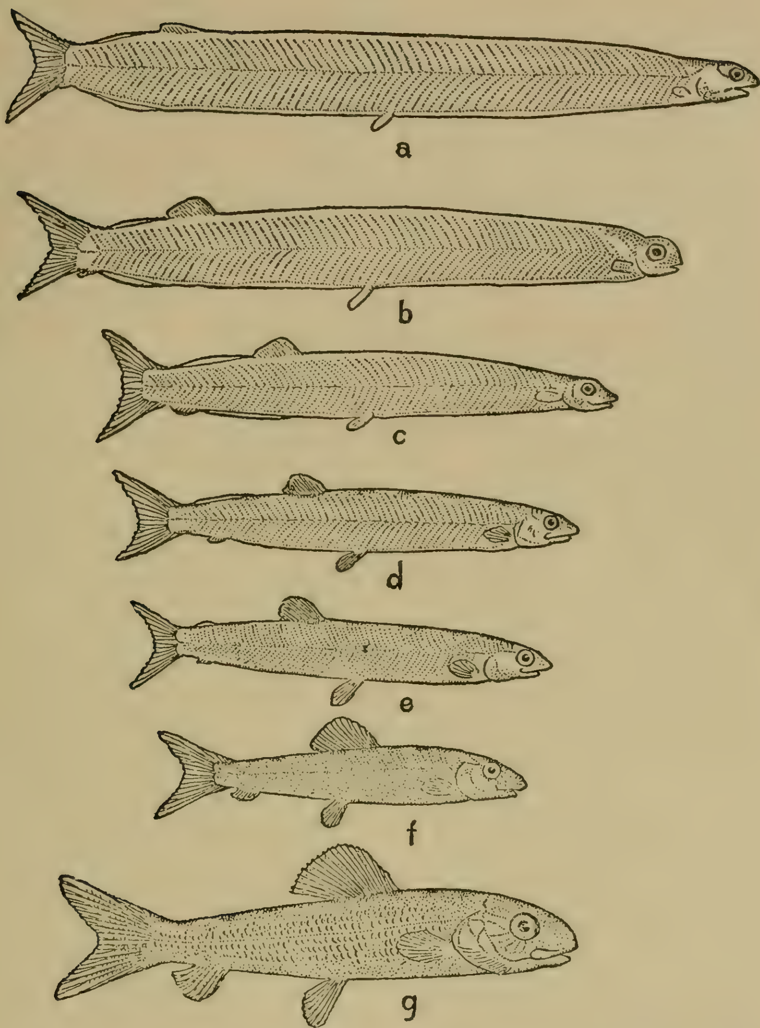


FIG. 7.—*Albula vulpes* (Linnæus). Transformation of the Ladyfish, from the translucent, loosely compacted larva to the smaller, firm-bodied young—slightly enlarged. Gulf of California. (After Gilbert and Jordan, Mss.)

A favorite region for the discharge of procreative duties is the Gulf of California. There the young may be found in immense quantities and they are "often thrown by the waves on the beach in great masses." But so different are those young from the mother fish that they would not be recognized by the casual observer. They are "elongate, band-shaped, with very small head and loose

transparent tissues." In the water in fact their eyes alone are visible. Gilbert tells that " from this condition they become gradually shorter and more compact, shrinking from three or three and a half inches in length to two inches." Then their form becomes much like that of maturity and from that stage they grow regularly till the proportions of ripe age are attained.[1]

The various phases of this remarkable growth during which, with advancing days, the developing fish grows smaller and smaller, have all been found by Professor Gilbert and drawn under his direction.[2] Having at length shrunk to almost half the length of the longest esunculoid stage and acquired a roundness and compactness of body as well as shape of the adult, it starts anew in growth and continues till the size and other characteristics of the adult are attained. The history of the metamorphosis of the species is quite as remarkable as that of the butterfly. With diminishing length, with increased compactness, the myotomes or muscular folds grow closer together and less obvious, the dorsal fin and, to a less extent, the anal become better developed and advance towards the middle, and innumerable minor or, rather, less evident changes accompany such until the adult form in miniature is obtained.

IV

One of its haunts is " the waters of Biscayne Bay and those extending some 60 miles further south," and by residents of that shore it " is not known to be found anywhere " else. There probably, at least, it is angled for as much if not more than elsewhere and is quite generally regarded as the gamiest fish that swims. There near Miami, August Thomas (1903) verified to his own satisfaction the verdict of the neighborhood. He approached a school, as is generally done, in a boat with a guide.

" Your guide works the boat towards them carefully, for they are as timid as a deer, and once frightened are very difficult to approach. When within 50 or 60 feet, which is as close as it is possible to get without frightening the fish, you cast the bait to a spot in line with the direction the fish are working, and not nearer than

[1] A brief notice of Prof. Gilbert's observations was communicated to Jordan and Evermann (I, 411), but Prof. Gilbert has informed the writer that his results are still unpublished. A figure of an esunculoid stage has been given by Boulenger (C. N. H., VII, 548) "after Gilbert," but otherwise no authority is mentioned.

[2] The writer is indebted to Professor Gilbert for a proof of the accompanying figure which is to be published in President Jordan's great forthcoming work on fishes.

20 or 30 feet to them. The bait is one of the shell-fish upon which the fish feed, and it must be absolutely fresh." This bait must be allowed to "lie immovable until the fish find it. The first indication is a slight nibble, for they are not vigorous biters, and they must be hooked, for they rarely hook themselves."

At length one is hooked. Then commences the sport. "From three to five hundred feet of line is taken out on the first rush, and this is often repeated twice or even three times, making from one thousand to fifteen hundred feet of line in all that is taken out in this manner. When these bursts of speed are over it is fight, fight, fight, every inch of the way to the boat, the runs growing shorter as the fish fails. When at length he sees the boat the mighty struggle comes, but not having strength to make a dash, he circles about the boat at a distance of from 10 to 20 feet, often making the circuit half a dozen times—when he finally comes alongside, belly up, he is dead—died as he had lived—dead game—and may be lifted into the boat with safety by the guide."

Fishes may be caught "from November to April, but it is at its best in December."

There is much diversity of opinion respecting the culinary characteristics of the lady-fish. Thomas thought that "as a table fish they have few equals, either planked or broiled." Goode, "from personal observation," testified that "its reputation is by no means a false one." In the Bermudas, too, "where large schools are taken" and where it is known as the Bone fish or Grubber, it is considered "a most excellent food-fish." Others, however, hold it in little esteem. Goode himself tells that along the southern coast of California where it is "found in some numbers," on account of "its beautiful color it sells readily, but it is not especially esteemed as a table-fish."

But it is by all with common consent exalted as a game fish. The celebrated angler Henshall, in 1884, declared that, of all the fishes he had caught in the Indian river inlet, "a bone-fish of about 3 pounds" gave more real sport than any of the others." He found that it "fights in the water and in the air like the black-bass, but mostly in the air—a silver shuttle."

The Gisu or Pterothrissus of Japan

A fish occurs in the deep sea off Japan, named gisu by the Japanese fishermen, which was considered to be the type of a peculiar family (Bathythrissidæ) related to the white fishes and other Salmonids by Günther but which later ichthyologists (Boulenger

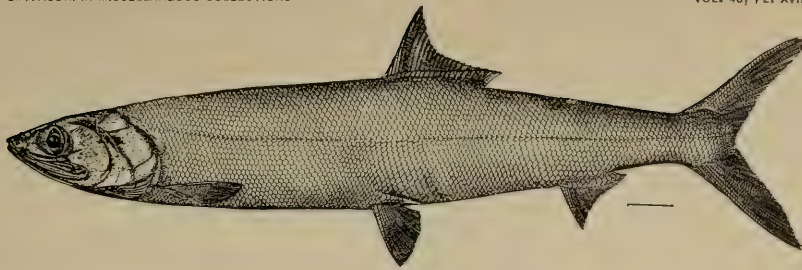
and Ridewood) have associated with the Albulids. It has been scientifically named *Pterothrissus gisu* and *Bathythrissa dorsalis* and may still be considered as the representative of an independent family, very closely related to the Albulids, but named Pterothrissidæ. The Pterothrissids are essentially like the Albulids but the branchiostegal rays are in reduced number (about six), the vomer and palatines are toothless, and the peculiar dentigerous bone which covers the basibranchials of the *Albula* is undeveloped. The dorsal fin is prolonged over most of the back and caudal region.

This family also is one of ancient origin, especially if Smith Woodward is correct in his statement that *Pterothrissus* "is not clearly distinguished from *Istieus*." Species of *Istieus* flourished in the seas whose deposits formed the upper Cretaceous beds of modern Westphalia and Mount Lebanon.

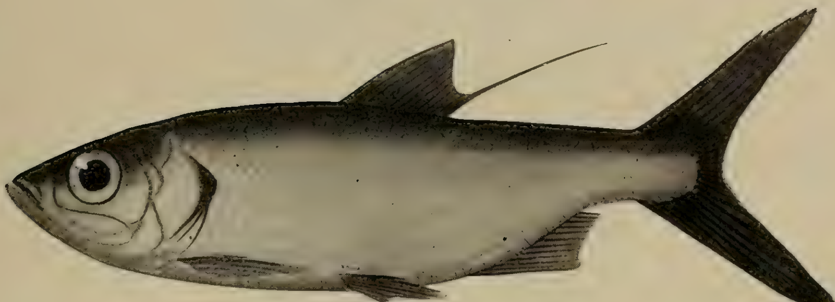
Only one species (*Pterothrissus gisu*) is known from existing seas; it is a deep-sea fish which occurs at depths of three hundred to four hundred fathoms off the Japanese archipelago. Nothing is known of its habits.

Abbreviations Employed in the Lettering of Figures (After Ridewood.)

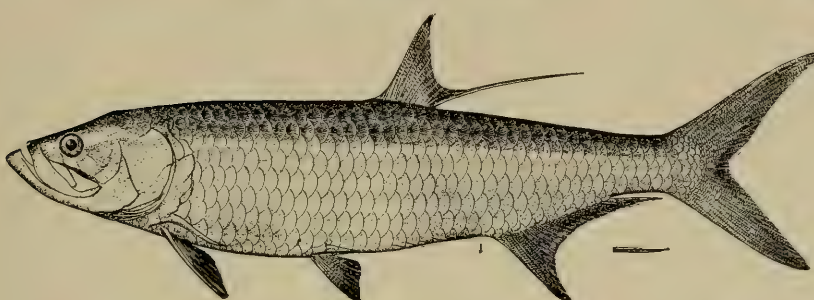
al, alisphenoid.
an, angular.
bb, dentigerous plate covering the basibranchials.
bo, basioccipital.
br, branchiostegal rays.
bs, basiphenoid.
cb, ceratobranchial.
ch, ceratohyal.
cor, circumorbital bones.
ct, cartilage.
d, dentary.
eb, epibranchial.
ecar, ectosteal articular.
ecp, ectopterygoid.
eo, exoccipital.
ep, epiotic.
f, frontal.
gh, glossohyal.
hb, hypobranchial.
hh, hypohyal.
hm, hyomandibular.
ih, interhyal.
iop, interopercular.
j, jugular or gular plate.
me, mesethmoid.
mpt, metapterygoid.
mx, maxilla.
n, nasal.
op, opisthotic.
opc, opercular.
or, orbitosphenoid.
p, parietal.
pb, pharyngobranchial.
pl, palatine.
pm, premaxilla.
pof, postfrontal.
pop, preopercular.
prf, prefrontal.
pro, pro-otic.
ps, parasphenoid.
pt, post-temporal.
ptf, posterior temporal fossa.
q, quadrate.
sar, sesamoid articular.
sm, surmaxilla.
soc, supraoccipital.
sop, subopercular.
sp, spicular bone.
sq, squamosal.
st, supratemporal.
stf, subtemporal fossa.
sy, sympletic.
v, vomer.



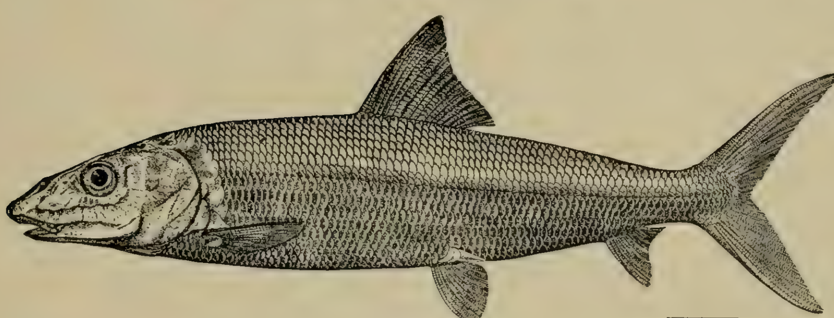
Ten-pounder (*Elops saurus*).



The Oxeye (*Megalops cyprinoides*).

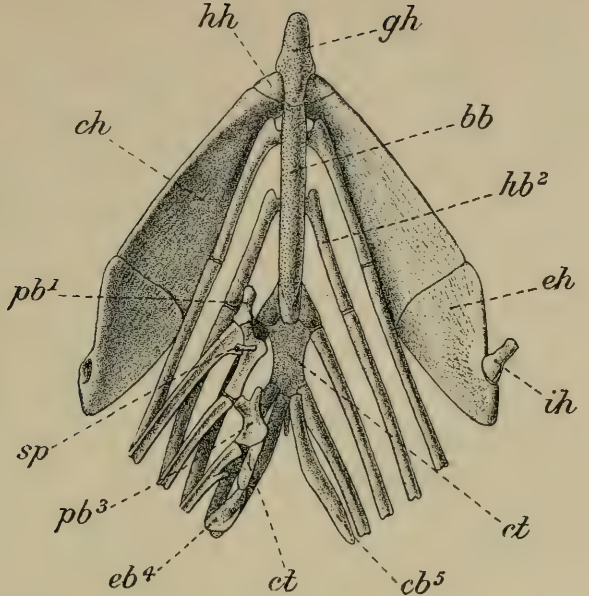


Tarpon (*Megalops atlanticus*).

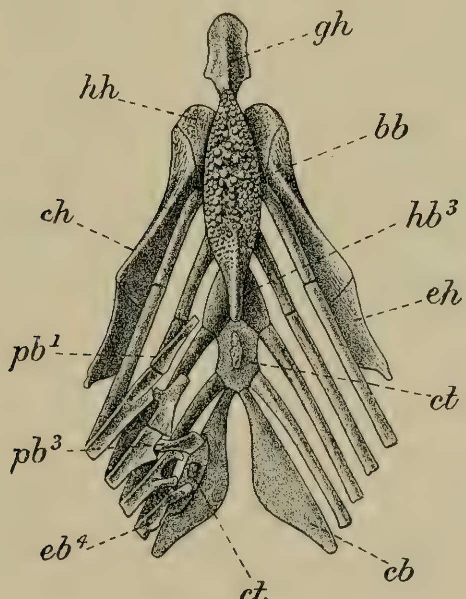


Ladyfish (*Albula vulpes*).

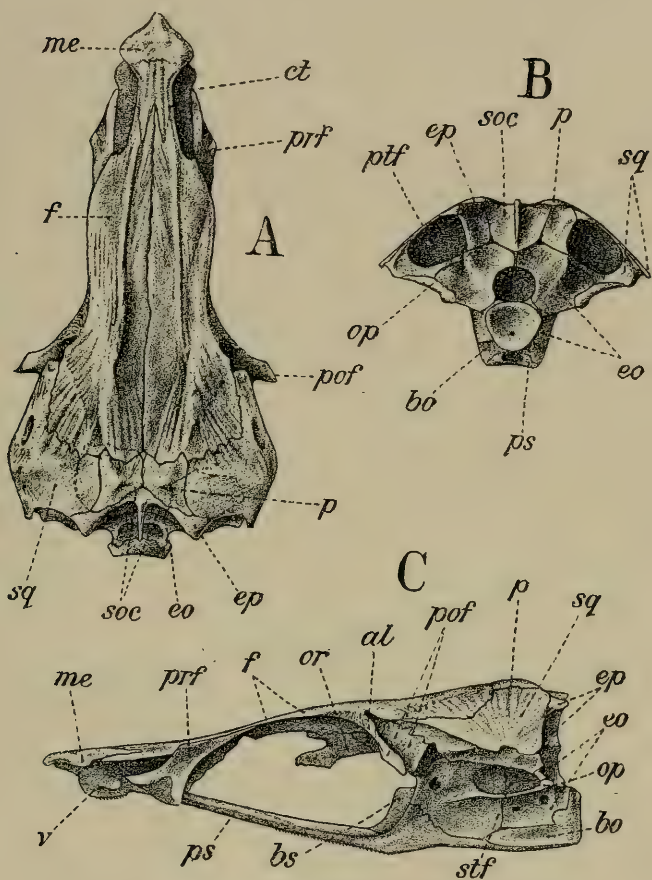
Gisu (*Pterothrissus gisu*).



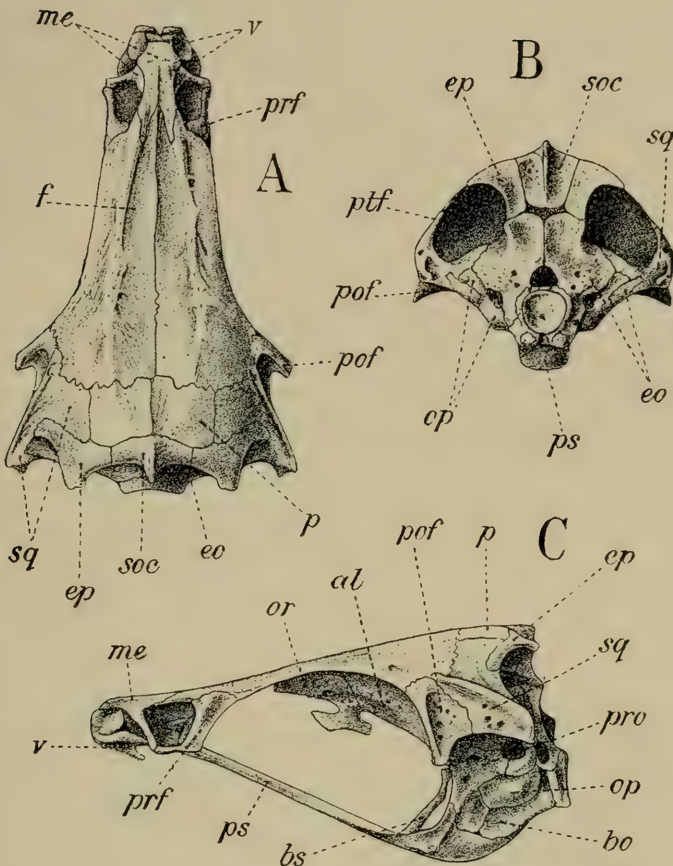
Elops saurus: hyobranchial skeleton from dorsal view. (The epibranchials and pharyngobranchials of the right side are not shown.)



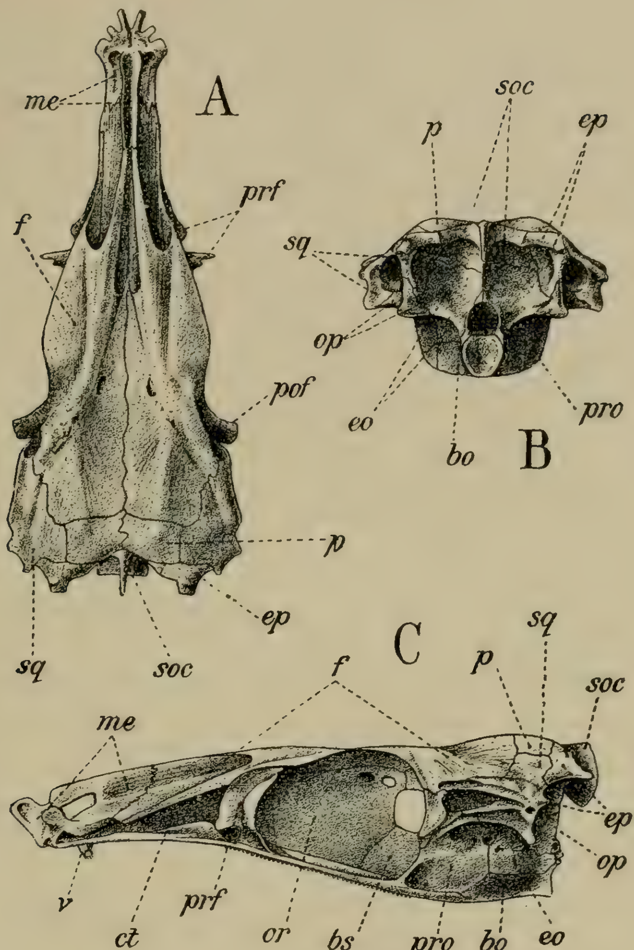
Albula conorhynchus: hyobranchial skeleton from dorsal view. (The epibranchials and pharyngobranchials of the right side are not shown.)



Elops saurus: cranium. *A,* dorsal view; *B,* back view; *C,* left side.



Megalops cyprinoides: cranium. *A*, dorsal view; *B*, back view; *C*, left side



Albula conorhynchus: cranium. *A*, dorsal view; *B*, back view; *C*, left side.

DIAGNOSIS OF A NEW GENUS AND SPECIES OF FOSSIL SEA-LION FROM THE MIOCENE OF OREGON

By FREDERICK W. TRUE,

Head Curator, Department of Biology, U. S. National Museum

At the suggestion of Mr. Wm. H. Dall, the National Museum purchased from Mr. B. H. Cammann of Empire City, Coos County, Oregon, in 1898, a portion of a large fossil skull from the soft Miocene sandstone of that locality. The specimen, as I am informed by Mr. Dall, was found by Mr. Cammann in the sandstone bluff on the east side of the lower part of Coos Bay, between Empire City and the "south slough," in the formation to which Mr. J. S. Diller has given the name of the "Empire Beds."

Upon examination, the skull proves, as Mr. Cammann had supposed, to be that of a sea-lion. It represents a genus allied to *Eumetopias,* but much larger. The fragment consists of the brain-case, or cranium proper, together with the pterygoids and the palatines as far forward as the posterior end of the hard palate. Both zygomatic processes of the squamosal are broken off near the root, and the right parietal bone has been lost, leaving a large opening through which the whole interior of the brain-case can be examined. The tympanic bullæ are crushed and splintered off down to the level of the basioccipital and so mingled with the matrix that their form is lost. The surrounding foramina are also obliterated, and the base of the skull thus presents a broad, nearly flat surface, the appearance of which is, at first sight, very misleading. In other respects, however, the fragment is in an excellent state of preservation, and presents characters which plainly indicate its affinities.

It has been deemed desirable to publish the following diagnosis and measurements in advance of a full description, with figures, which will appear later in one of the publications of the U. S. Geological Survey.

PONTOLEON new genus

Similar to *Eumetopias,* but with the ventral surface of the basioccipital nearly plane, and the dorsal surface strongly concave. Postglenoid process of the squamosal strongly produced distally and directed somewhat posteriorly, so that the glenoid fossa is broader

distally than proximally. Dorsal surface of squamosal, between the wall of the cranium and the zygomatic process, concave antero-posteriorly throughout its whole extent. Hard palate abbreviated, the posterior margin concave.

PONTOLEON MAGNUS new species

Size much larger than that of the largest of existing eared-seals. Skull when complete probably about 50 cm. (or 20 inches) long.

DIMENSIONS OF THE TYPE-SKULL OF *Pontoleon magnus* AND OF TWO ADULT SKULLS OF *Eumetopias jubata*.

Measurements.	*Pontoleon magnus* Type No. 3792.	*Eumetopias jubata.*	
		Bering Id., Kamchatka No. 49729.	St. Paul Id., Alaska, No. 49730.
	cm.	cm.	cm.
Total length (basi-cranial)		40.1	36.5
Total height posteriorly (from line of occipitomastoid processes to top of occipital crest in a straight line)	19.1	17.0	15.2
Greatest breadth between occipitomastoid processes	24.8[1]	23.2	21.6
Greatest breadth between outer margins of zygomatic processes of squamosal	25.0[2]	23.9	23.1
Greatest breadth between outer margins of occipital condyles	11.0	9.0	8.6
Height of occiput from upper margin of foramen magnum to top of occipital crest	11.2	9.2	8.1
Height of foramen magnum	5.7	4.5	4.7
Breadth of foramen magnum	4.1	3.9	3.7
Length of an occipital condyle	8.1	6.2	6.4
Breadth of an occipital condyle	3.7	3.4	3.1
Greatest transverse breadth of occipital crest	15.4	15.8	13.8
Breadth between occipital condyles inferiorly	1.7[3]	2.1	1.7
Greatest breadth of occipitomastoid process antero-posteriorly	7.1	5.9	5.2
Distance from inferior margin of foramen magnum to outer inferior angle of exoccipital	8.6	8.2	7.8
Distance from outer inferior angle of exoccipital to postglenoid process of squamosal	10.2	7.8	7.2
Distance from inferior margin of foramen magnum to tip of hamular process of pterygoid	13.4	11.6	10.9
Distance from tip of hamular process of pterygoid to posterior end of hard palate	10.2	6.0	5.1
Distance from surface of occipital condyles to end of hard palate	24.1	19.1	17.2
Greatest breadth between outer walls of ascending plates of palatines at their posterior end	8.6	5.7	5.6
Greatest breadth of posterior nares	5.1	3.6	3.9
Length of glenoid fossa of squamosal (transverse)	7.1	7.5	6.3
Length of glenoid fossa of squamosal (antero-posterior)	4.1	3.9	3.2

[1] Actually 24.0 cm., but the left side is broken and 0.8 cm. has been added to agree with the right side.

[2] Actually 23.0 cm., but the right side is broken.

[3] The condyles are a little defective below.

Distance from the occipital condyles to the posterior end of the hard palate nearly equal to the mastoid breadth of the skull. Occipitomastoid processes widely divergent, compressed laterally, nearly plane internally. External wall of the ascending plate of the palatines thickened, forming a strong rounded ridge. Posterior nares as broad as deep.

Type.—No. 3,792, U. S. N. M. (Vert. Pal.). Empire Beds (Miocene) of Empire City, Oregon. Collected by B. H. Cammann.

DIATOMS, THE JEWELS OF THE PLANT-WORLD[1]

BY ALBERT MANN

To anyone familiar with the beautiful plants which form the subject of this lecture it seems strange that so few people know of their existence, for they are abundant everywhere. The evident explanation of this, however, is the extreme minuteness of these organisms, most of which are wholly invisible to the naked eye. Among the 4,000 or more species there is one, *Coscinodiscus rex,* a perfect Goliath among his brethren, which is nearly as big as the head of an ordinary pin; but with this exception, the larger forms can better be compared to the point of the pin, while many are so extremely small that the highest powers of the microscope are needed to display their form and the carvings with which they are ornamented.

The diatoms belong to the group of flowerless, aquatic plants known as the Algæ. Where these are divided into six groups the Diatoms constitute one of the six; thus (1) Rhodophyceæ, the red algæ; (2) Phæophyceæ, the brown algæ; (3) Chlorophyceæ, the green algæ; (4) Bacillariæ, the diatoms; (5) Heterokontæ, the yellow-green algæ; (6) Cyanophyceæ (Myxophyceæ), the blue-green algæ. I am disposed, however, to classify them as a sub-order in the Order *Conjugatæ* belonging to the green algæ, or Chlorophyceæ; and for the following reasons—(1) they have a unicellular thallus, (2) they have large, elaborate and symmetrically arranged chloroplasts, (3) they frequently produce resting-cells with thick walls, (4) they secrete gelatinous masses in which the individuals are embedded, (5) they display a double mode of multiplication, namely, that by fission, or division of one cell into two, and that by sexual reproduction by means of non-motile isogametes. The attempt to classify them with the brown algæ is absurd.

The distribution of the diatoms is practically universal. They occupy all waters, torrid, temperate, and arctic; fresh, salt, and brackish; still and running. There is hardly a brook, pond, puddle, lake, river, or sea on earth that is destitute of these plants, unless the water be so contaminated with poisonous matter as to inhibit all life. The largest and most elegant forms belong to the tropics, but

[1] Delivered at the U. S. National Museum, Washington, D. C., March 18, 1905, under the auspices of the Washington Biological Society.

the most amazing numbers of individuals are found in the arctic regions. Dr. Nansen found them in undiminished abundance at the northern limits of his polar journey.

Geologically the diatoms seem to have first appeared in the closing measures of the Middle Cretaceous; in other words, they are, though low in organic complexity, comparatively recent in the scale of successive life-forms. The statement of Castracane, that they have been found in the Carboniferous Era, and the still more amazing claims that have been made of finding them in Devonian and even Silurian deposits are generally discredited. It should be remarked here that the precise period of entrance of these organisms should be quite clear, because of the prolific multiplication of individuals characteristic of these forms on the one hand and of the indestructible nature of their remains on the other.

Diatom structure can be best understood by looking first at the external skeleton or casing, and then at the living substance within it. Each plant, a unicellular individual, secretes for itself an external case or box of clear and very dense silica, consisting of two valves, an upper and a lower, the one slipping over the other like the lid and bottom of an ordinary pasteboard box, Figs. 8 and 9, *A, B*. This case is not of uniform shape; but among the 4,000 or more species there can be found almost every conceivable form, so long as the form displays symmetry on one or both of its axes. Thus there are round, square, triangular, stellate, oval, ovoid, crescent, sigmoid, cuneate, bacillar, etc., forms. It is evident that this great variety in the symmetrical contour of these structures adds considerably to their beauty and attractiveness. The variety is further enhanced by numerous outgrowths in the form of spines, horns or domes, so arranged as to preserve the symmetry of the valves from which they spring. The two valves themselves, which are with few exceptions identical in shape and markings, are carved and ornamented with an elegance and variety that is well-nigh inconceivable. Indeed it may safely be stated that there is hardly a kind of surface ornamentation known that has not been utilized in beautifying these structures. Polished beads of varying size arranged in radiating or concentric rows, shining bars, wavy ridges, delicate

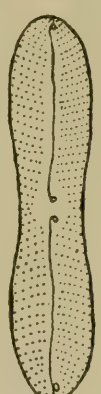


FIG. 8.

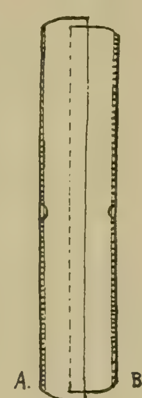


FIG. 9.

watch-case milling, hexagonal network, the interspaces of which are often further ornamented with secondary sculpture, intricate arabesque designs, in short a diversity and delicacy of embellishment that makes these plants the most ornate of all living objects. The highest efficiency of the microscope is often taxed in revealing some of the minuter markings; and valves that were formerly thought to be quite smooth, and which, therefore, bear the inappropriate name, "hyaline" or "pellucida," are now under better objectives found to be intricately carved with intersecting lines. It should be here stated that the few illustrations accompanying this description convey no adequate idea of the objects they represent; for in black and white it is quite impossible to reproduce the appearance of these structures of shining silica, often further beautified by prismatic colors refracted from their various surfaces.

Outside of this silica casing there is a very thin and perfectly transparent organic pellicle, in vital connection with the living substance within, erroneously called a gelatinous sheath. It is this internal living substance which determines the position of the organism as a plant, and which presents some of the most interesting problems connected with its life-history. It is made up of normal plant protoplasm (cytoplasm) with a single large centrally placed nucleus. Rarely there are two nuclei, found only in two or three species, where they are said to be constant. Generally there are two large vacuoles filled with cell-sap, and two or more chloroplasts. These latter are usually symmetrically arranged, in the elongated diatoms on either side of the median line and in the circular forms in evenly distributed granules or larger masses radially disposed. The green chlorophyl composing these bodies is disguised by an overlying brown or buff pigment called diatomin, which is so readily soluble in alcohol that when living diatoms are treated with that liquid the diatomin instantly disappears and the plants are seen to be bright green. The reserve food material stored up by the diatoms is not in the form of starch grains, but of globules of deep yellow, dense and highly refractive oil, either floating in the sap of the vacuoles or embedded in the cytoplasm.

Turning now to the physiology of the diatoms the question of their nourishment may be considered. This takes place as in other chlorophyl-bearing plants, by the assimilation of inorganic substances in solution in the water about them through the agency of sunlight in conjunction with the chlorophyl masses; and in consequence of this fact it is plain that they are precluded from such waters as are not sufficiently lighted; as, for example, subterranean streams and the

deeper parts of the sea. No actual test has been made of the ocean depth at which diatoms can flourish, but the limit is probably something below 100 fathoms. Specimens of diatoms are, it is true, obtained from all depths, even from the abysses of 6,000 fathoms or more; but in such cases they are invariably the dead and empty frustules of plants that have been transported there by surface currents. There are a few diatoms partly or wholly destitute of chlorophyl and which therefore live a saprophytic life. Such is *Nitzschia putrida*, a colorless form, and *Bacillaria paradoxa* another *Nitzschia*, which is only partly saprophytic and therefore not wholly colorless.

The food-product of assimilation can never be utilized by the individual plant to any great extent; for being encased in an in-

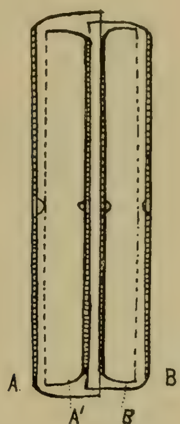


FIG. 10.

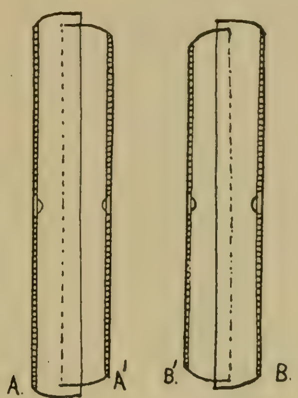


FIG. 11.

flexible silica box its chance of growth is restricted to a very slight increase in breadth by the slipping apart of the upper and lower valves or lids: in other words, each diatom is formed at its own maximum length. Most of the reserve food is therefore utilized in the multiplication of individuals. This takes place in two curious ways. The first and common method is the asexual one of fission, or the separation of a single plant into two along a median dividing line. Although this is the usual method of multiplication in unicellular plants as well as in single cells of multicellular plants, the process in the diatoms is peculiar in taking place, not transversely, that is along the short axis, as is done in the bacteria, the other algæ, etc., but longitudinally from end to end. This peculiarity is the origin of the name "diatom," from δία τομέω, to cut through. An examination of Figs. 10 and 11 will make this process clear. It is easy to see that

smaller individuals must be formed at each repetition of this process, as the two new valves are always formed within the old ones. The diatom loses approximately one-sixtieth of its length by this method; and if it were continued indefinitely the forms would necessarily dwindle to the vanishing point! This however is corrected by means of the second or sexual method of reproduction, a process that brings about two important results; the diatom's vitality is rejuvenated and its ancestral size is restored. This process, called conjugation, may take place in any one of three ways; —

1. The nucleus of a single diatom divides karyokinetically; the cell contents swell, bursting apart the valves; the mass passes out into the water, becomes spherical, secretes a large quantity of jelly-like substance; the two daughter nuclei reunite; a large "auxo-

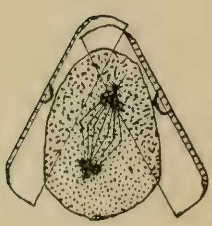


FIG. 12.

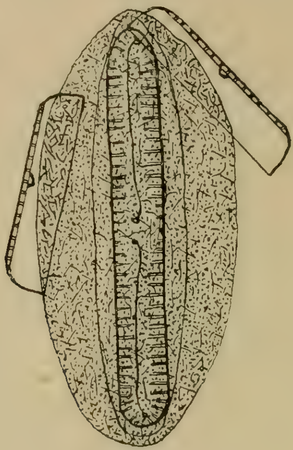


FIG. 13.

spore" is formed, and within this a single large diatom is built, like the parent frustule, but approximately double the size. See Figs. 12 and 13.

2. The second method is where two diatoms come into contact; the contents swell, as before; the two nuclei remain undivided, but fuse together and produce a single auxospore, within which a single diatom, double the former size, is again formed. See Fig. 14.

3. In the third method two parent diatoms join; the nucleus of each divides karyokinetically; the four daughter nuclei unite, the two from one plant with the two from the other, producing two auxospores and giving rise to two large frustules. See Fig. 15.

The first method is common among diatoms that are fixed, and especially those which grow in long filaments. The second is

rather uncommon, being confined to a few species. The third is perhaps the most frequent of all and is especially characteristic of the moving diatoms.

Conjugation takes from eight to twenty days for its completion; and as the diatoms lose by each act of fission about one-sixtieth in length, and as they divide every five or six days under normal conditions of nourishment, it would require not more than one act of conjugation yearly to balance the reduction. Frequently conjugation does take place only once in a year; and then it is, at least in our latitude, quite uniformly early in spring, often before the ice has entirely disappeared from the streams.

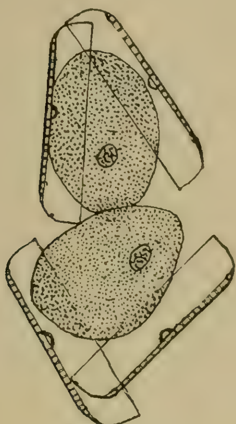


FIG. 14.

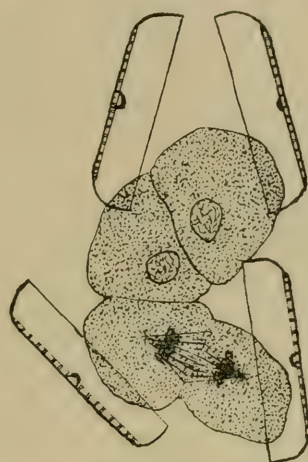


FIG. 15.

Two other methods of reproduction are claimed as taking place among the diatoms; namely, by means of exceedingly minute spores; and by means of daughter plants, two to sixteen in number, formed within the body of the parent plant. But as the former is wholly unsubstantiated, and the latter, described by G. Murray (in *Proc. Roy. Soc. Edin.*, vol. 21) is, to say the least, most anomalous, no attempt will be here made to describe them.

There is one other physiological process of the diatoms which has up to the present time puzzled all its investigators, their motion. Many of the diatoms grow attached to some support, some of the round and oval forms lying flat on the fronds of other algæ, while others are fixed at the ends of gelatinous stalks, singly or in clusters, or grow as zigzag chains or in rows like beads or in flat bands as long filaments. But large numbers are free; and these, especially

Nitzschia and *Navicula,* display a liveliness of motion that is easy to watch but hard to understand. The majority of these forms are boat-shape, and their motion has a stately character quite different from the erratic movements of the lower animal organisms. But these tiny crafts move without oar or sail, paddle-wheel or propeller. They apparently present the anomaly of moving without any organ of locomotion! Many theories have been invented to explain this mystery; as fine protruded pseudopodia (Ehrenberg), osmotic currents of water (Naegli and H. L. Smith), rows of cilia (J. D. Cox), a stream of protoplasm moving along the "raphe" a line on each valve, generally in the middle that is thought to be a narrow cleft (Muller). But none of these fit the case. No method of staining known has been able to show any protrusions. Whatever be the final explanation, it must explain not swimming but creeping; for these organisms are perfectly inert and helpless unless in contact with some fixed surface. This alone disposes of all theories requiring cilia, flagellæ, osmotic currents, etc. The power, too, must be considerable; for diatoms will push aside in their course inert matter many times their bulk. The theory must also apply to the *ends*

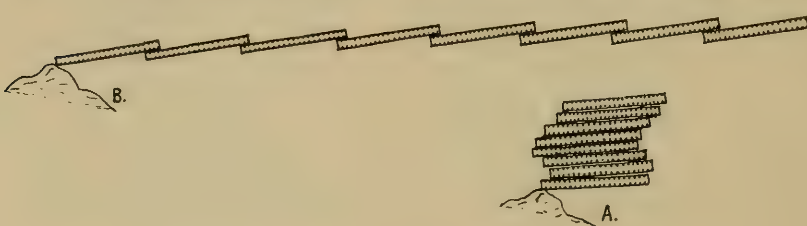


FIG. 16.

of the frustules; for the plant will often stand upon end and swing about most vigorously. It is not at all improbable that the so-called "gelatinous sheath," which overlies uniformly the entire external surface and is connected with the living cell contents through numerous minute pores, is the seat of this motion, and by undulatory movements over its surface produces the phenomenon that is so evident and so puzzling. Any one who will watch the strange accordeon-like extending and retracting movements of those well-named diatoms, *Bacillaria paradoxa,* especially when, fully extended, they touch each other only at the tips and yet form a series as rigid as a rod, will see that some explanation based on the external membrane fits the case better than any other. See Fig. 16, *A* and *B*.

A few words should be said upon the practical uses of the diatoms. The first of these is as polishing powders. Under the name of " tri-

poli" they have been long in use to give brilliancy to metallic and other surfaces; while, either mixed with soap or put up dry, they are sold under fancy names for the same purpose. One widely known brand of tooth-powder is composed entirely of diatom shells. As an absorbent of nitro-glycerine they have been extensively used in the manufacture of various dynamite compounds. They are also employed as a substitute for asbestos in the composition of jackets for steam-pipes, as packing in refrigerators, etc. They have at least a semi-practical use in refuting the utilitarian theory of the origin of species; their rigidly exact yet infinitely diversified carving and ornamentation refusing absolutely to fit into such a conception. Diatoms have a most curious use among the more abject inhabitants of Lapland and Bohemia as a substitute for or an adulterant of food. Under the name of "berg mehl" diatomaceous earth is mixed with flour, fat, etc., and eaten. It is hardly supposable that this fossil earth contains any appreciable amount of nourishment. The philosophy of the practice is probably the fact that where a hungry man has a stomach capacity of two quarts and a food supply of only a pint, he can cajole himself and gain a sense of plethoric bounty by adding three pints of inert matter to his supply,—a sort of "square meal," it is true, but a very hollow one! The diatoms do, however, form a considerable part of the world's food supply, at least in an indirect way; for they are one of the principal sources of nourishment for mollusks, the clams, oysters, etc., whose stomachs always contain large quantities of these plants; as well as constituting a good part of the food of small fishes and of the animal organisms on which larger fish feed. Thus they are a sort of primary source of organic food, on the abundance of which many of our most valued food products depend.

It is well to mention here that the diatoms give promise of great practical value in determining the origin of sea-bottoms and the direction and extent of the sea-currents by which they are transported. Their use to applied science in this respect is now being investigated.

There will be no difficulty for anyone interested in the examination of these plants in finding them, either as living or fossil forms. Wherever there is a brown coloration of the surface of the mud, submerged stones or twigs, not a red-yellow, which is due to iron, but a brown-yellow to almost black, there are diatoms in abundance. It is their characteristic color, when found in masses; and a little of the material placed under the microscope will reveal thousands of them. Or if fossil material is needed, diatomaceous earth can be

found in almost every State in the Union and almost every land on earth. Immense beds exist, for example, at Nottingham, Md.; Richmond, Va.; Keene, N. H.; Monterey, Santa Monica, Rodondo Beach, Cal.; near Spokane, Wash.; etc.; while smaller deposits are frequent in many other localities. In foreign lands there are large deposits at Sendai, Japan; Ananino and Simbirsk, Russia; Alicate, Sicily; Bilin, Bohemia; Luneberg, Germany; Mors, Jutland; Oamaru, New Zealand; Springfield, Barbados; etc.

The cleaning of diatoms of organic matter and the preparation of these and fossil forms as permanent microscopic mounts cannot be entered into here. The processes are easily learned from any good work on the microscope.

SMITHSONIAN INSTITUTION,
WASHINGTON, D. C., March, 1905.

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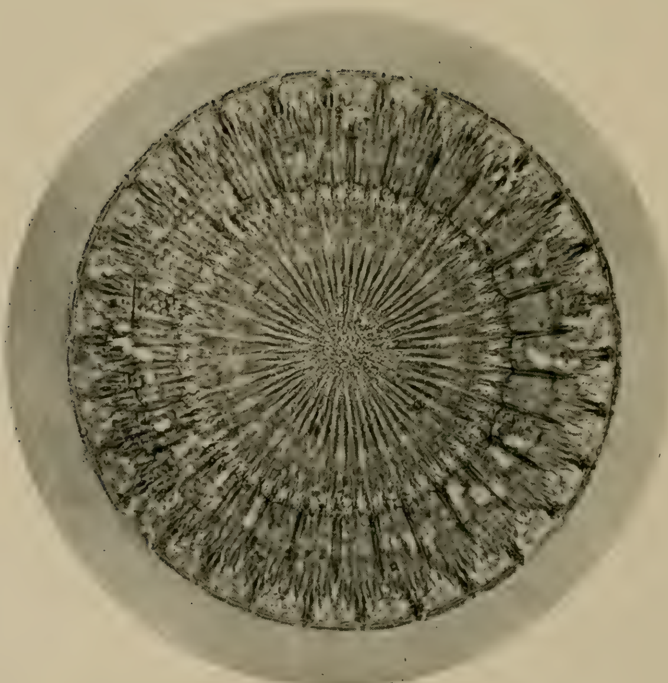


2

DIATOMS

Plate XXII

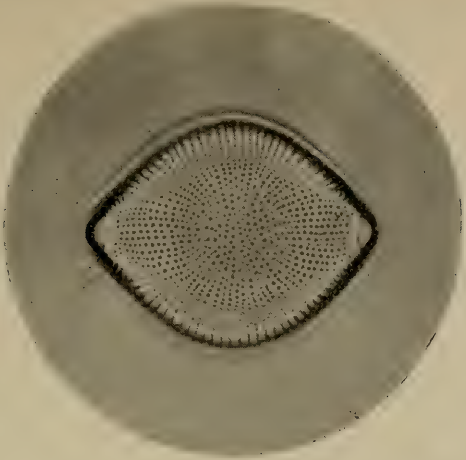
Figure 1. *Coscinodiscus asteromphalus,* E., × 185. Sendai, Japan. Photograph by A. A. Adee.

2. *Lepidodiscus elegans,* Witt., × 620. Simbirsk, Russia. Photograph by A. A. Adee.

Plate XXIII

Figure 1. *Biddulphia Roperiana,* Grev., variety *mollis,* Mann, × 400. Pacific Ocean, S. S. "Albatross," station 3608.

2. *Plagiogramma sceptrum,* Mann, × 375. Galapagos Islands.
3. *Stephanopyxis ferox,* Grev., × 400. California guano. From Moebius' Plates of Diatoms.
4. *Triceratium* sp.? × 660. Bering Sea.
5. *Entogonia Davyana,* Grev., × 300 (= *Heibergia Barbadensis*) Barbados. From Moebius' Plates of Diatoms.



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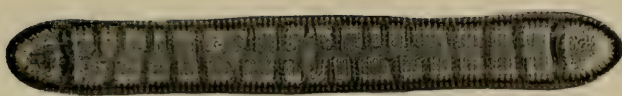

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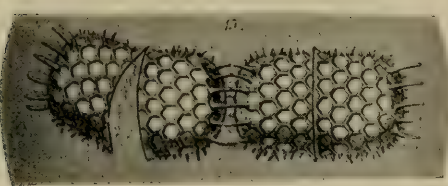

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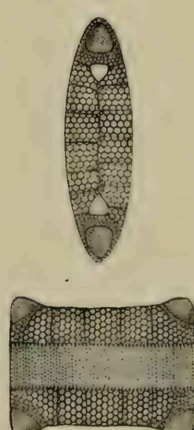

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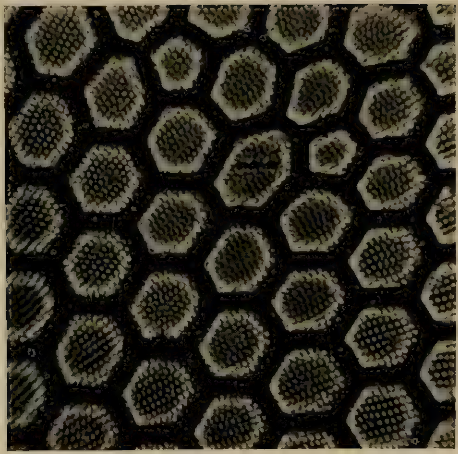

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DIATOMS

Plate XXIV

Figure 1. Secondary markings within the hexagonal network of *Triceratium favus*, Bright, × 1060. Oamaru, N. Z. Photograph by A. A. Adee.

2. Amphora, n. s., × 565. Pacific Ocean.

3. *Triceratium Campechianum* Cl., × 720. Florida. Photograph by A. A. Adee.

PLATE XXV

FIGURE 1. *Cestodiscus ovalis,* Grev., × 335. Moron, Spain. From Moebius' Plates of Diatoms.

2. *Actinoptychus Wittianus* O. Jan., × 200. Hayti. From Diatomaceen, Jeremie in Hayti.

3. *Brunia japonica,* Temp., × 100. Japan.

4. *Aulacodiscus* n. s., × 1000. Pacific Ocean, S. S. "Albatross," Station 4029 H.

5. *Navicula invenusta,* Mann, × 375. Galapagos Islands.

6. *Navicula bullata,* Norm., × 350. Western Australia. From Moebius' Plates of Diatoms.

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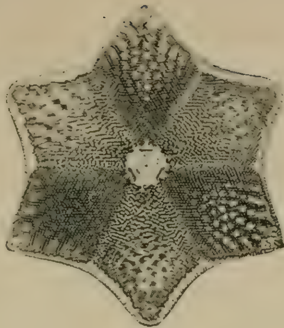

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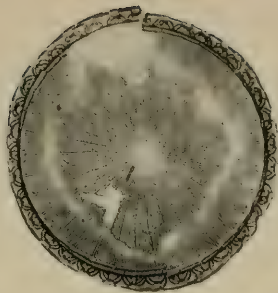

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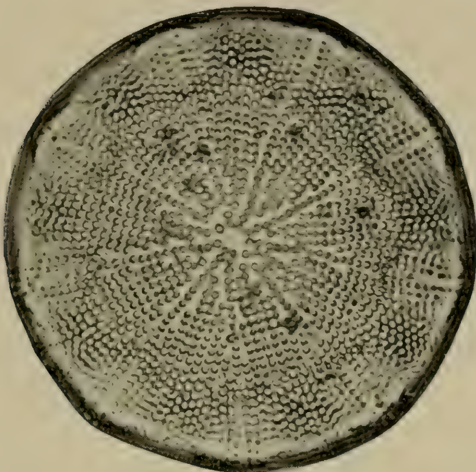

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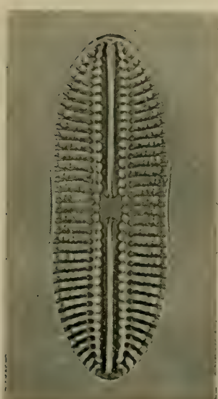

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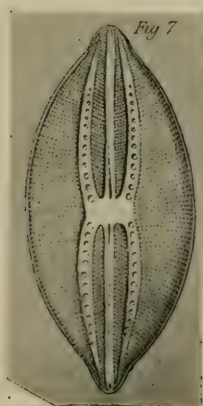

6

DIATOMS

NOTES ON THE NOMENCLATURE OF CERTAIN GENERA OF BIRDS

By HARRY C. OBERHOLSER

The following notes concern the status of some seventeen generic and a few specific terms that seem to require change. Most of these, though for several years held in abeyance by the writer, appear not yet to have been published by others; a few are revivals of former changes that lately have been ignored; and one or two have been mentioned as probably necessary by recent writers who failed to go farther. The alterations in specific names pertain only to species belonging to the genera treated.

The writer is under obligation to Dr. Charles W. Richmond for various courtesies in connection with the preparation of this paper, and wishes here to express his consequent appreciation.

BELLONA Mulsant and Verreaux

This name,[1] employed by authors for a genus of West India hummingbirds, is, as already pointed out by Mr. J. H. Riley,[2] untenable, being preoccupied by *Bellona* Reichenbach,[3] a genus of ornithicnites. In seeking a name for the group, however, Mr. Riley rejects the once used *Orthorhyncus* Lacépède[4] as a nomen nudum because "no type was specified and the diagnosis is not diagnostic," but revives it to date from Froriep,[5] and by elimination fixes as its type *Trochilus mosquitus* Linnæus. Then, since *Orthorhyncus* would thus take the place of the present *Chrysolampis,* Mr. Riley, still by process of elimination, transfers the name *Chrysolampis* to the group now known as *Eulampis,* and the term *Eulampis* to the unidentified "*Trochilus niger*" Wied. This arrangement leaves the preoccupied *Bellona* without a name, and it is accordingly christened *Microlyssa.*[6] These changes, however, can not stand, because *Orthorhyncus* is the proper name for *Bellona,* as may easily be shown; and they furthermore constitute a forcible illustration of the

[1] *Bellona* Mulsant and Verreaux, *Classif. Troch.,* 1866, p. 75.
[2] *Auk,* 1904, p. 485.
[3] Riley, *Auk,* 1904, p. 485.
[4] *Natürl. Syst. Vögel,* 1852, p. xxx.
[5] *Tabl. Ois.,* 1799, p. 9.
[6] Duméril's *Analyt. Zool.,* 1806, p. 47.

instability and unsatisfactory nature of generic type determinations by elimination.

The genus *Orthorhyncus* was instituted by Lacépède[1] for the "Oiseaux mouches," undoubtedly of Buffon, a group of twenty-four species, to one of which the name of course must be applied; so that *Orthorhyncus* stands on equal basis with the other names of Lacépède proposed in the same place, which have been subsequently accepted without question. The type of *Orthorhyncus* was fixed as *Trochilus cristatus* Linnæus by Gray in 1840;[2] and happily enough the same species also becomes the type if this be determined by elimination.

The species of this group should therefore stand as follows:

Orthorhyncus cristatus cristatus (Linnæus).
Orthorhyncus cristatus emigrans Lawrence.
Orthorhyncus ornatus Gould.
Orthorhyncus exilis (Gmelin).

DROMÆUS Vieillot

This name, spelled as above, does not occur in Vieillot's "Analyse," and so far as we are aware was never used by this author. He does, however, in the main part of this work propose *Dromiceius* for the emus, type *Casuarius novaehollandiæ* LATHAM;[3] and in the supplementary list where he gives the derivations of his generic names, he inserts instead of *Dromiceius* the term *Dromaius*[4] which Ranzani later emended to *Dromæus*.[5] Since *Dromiceius* can scarcely be considered a typographical error for *Dromaius*, it follows that the former, standing first in the book, becomes the proper name for the genus.

The species are:

Dromiceius novæhollandiæ (Latham).
Dromiceius ater (Vieillot).
Dromiceius irroratus (Bartlett).
Dromiceius patricius (De Vis) (fossil).
Dromiceius gracilipes (De Vis) (fossil).
Dromiceius queenslandiæ (De Vis) (fossil).

HYDRORNIS Milne-Edwards

The fossil genus *Hydrornis* Milne-Edwards[6] is preoccupied by *Hydrornis* Blyth, used for a member of the Pittidæ (*Paludicola*

[1] *Tabl. Ois.*, 1799, p. 9.
[2] *List Gen. Birds*, 1840, p. 14.
[3] *Analyse*, 1816, p. 54.
[4] *Analyse*, 1816, p. 70.
[5] *El. di. Zool.*, III, pt. 1, 1821, p. 98.
[6] *Rech. Oiseaux Foss. France*, I, 1867, p. 362, Tb. 57, fig. 18–22.

nipalensis Hodgson).[1] It may be replaced by *Dyspetornis,* from δυσπετής, difficilis, and ὄρνις, avis. The type and only species, *Hydrornis natator* Milne-Edwards,[2] should therefore now be called:

Dyspetornis natator (Milne-Edwards).

NÆNIA Boie

The name *Nænia* Boie[3] is untenable by reason of *Nænia* Stephens,[4] employed for a genus of Lepidoptera. The next available name is apparently *Larosterna* Blyth;[5] but the book in which this was published, though bearing on its title page the date 1849, contains internal evidence to show that it did not appear until at least 1852. This gives priority to *Inca* Jardine,[6] which has the same species, *Sterna inca* Lesson, as its type. The only species of this group, therefore, now becomes:

Inca inca (Lesson).

GNATHOSITTACA Cabanis

An earlier name for *Gnathosittaca* Cabanis[7] which is based on *Gnathosittaca heinei* Cabanis (= *Conurus icterotis* Massena and Souancé) is found in *Ognorhynchus* Gray,[8] type *Conurus icterotis* Massena and Souancé.

The sole species is:

Ognorhynchus icterotis (Massena and Souancé).

DASYPTILUS Wagler

The generic name commonly applied to *Psittacus pecquetii* Lesson is *Dasyptilus* Wagler;[9] but this is, however, antedated by *Psittrichas* Lesson,[10] used for the same bird.

This species should therefore stand as:

Psittrichas pecquetii (Lesson.)

NANODES Vigors and Horsfield

The term *Nanodes* Vigors and Horsfield[11] for a group of Psittacidæ

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[1] *Journ. As. Soc. Bengal,* XII, 1843, p. 960.
[2] *Loc. cit.*
[3] *Isis,* 1844, p. 189.
[4] *Ill. Brit. Ent.,* II, 1829, p. 165.
[5] *Cat. Birds Mus. As. Soc.,* 1852, p. 293.
[6] *Contrib. Orn.,* 1850, p. 33.
[7] *Journ. f. Ornith.,* 1864, p. 414.
[8] *List Psitt. Br. Mus.,* 1859, p. 33.
[9] *Abhandl. Ak. Wissensch. München,* I, 1832, p. 502.
[10] *Illustr. Zool.,* 1831, pl. i; Ferussac's *Bull. des Sci. Nat.,* XXV, June, 1831, p. 341.
[11] *Trans. Linn. Soc.,* XV, Feb., 1827, p. 274.

is rendered untenable because of *Nanodes* Schönherr,[1] a genus of Coleoptera. Some time ago Forbes proposed to put *Lathamus* Lesson in place of *Nanodes* Vigors and Horsfield, dating the former from 1831,[3] and considering its type to be *Lathamus rubrifrons* Lesson (=*Psittacus discolor* Shaw); but the earlier use of *Lathamus,* also by Lesson, as a subgenus of *Psittacus,* for *Psittacus, aurifrons* Lesson,[4] makes it a synonym of *Bolborhynchus* and thus unavailable for *Nanodes.* The next and only other synonym of *Nanodes, Euphema* Wagler,[5] becomes consequently its tenable title, since this is not invalidated by *Euphemus* Rafinesque,[6] a nomen nudum.

The type and sole species ought therefore to be called:

Euphema discolor (Shaw).

DENDRORNIS Eyton

The name of the group of Dendrocolaptidæ to which the generic term *Dendrornis* Eyton[7] has been applied must apparently be changed. The type of *Xiphorhynchus* Swainson as usually cited[8] is *Dendrocolaptes procurvus* Temminck; but earlier in the same year Swainson had used this generic name in describing *Xiphorhynchus flavigaster,*[9] which is a member of the present genus *Dendrornis.* Although Swainson evidently intended to make *Dendrocolaptes procurvus* Temminck the type of *Xiphorhynchus,* he defeated his purpose by allowing the previous publication of *Xiphorhynchus* in combination with the name of a species of another group, such publication being quite sufficient to fix the name of a genus. Since in this case the question is not complicated by the mention of any other species, *Xiphorhynchus flavigaster* Swainso[10] must be considered the type of *Xiphorhynchus,* and this generic term therefore transferred to displace *Dendrornis.*

The species are as follows:

Xiphorhynchus guttatus (Lichtenstein).

Xiphorhynchus guttatoides (Lafresnaye).

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[1] *Curc. Disp. Meth.,* 1826, p. 322.

[2] *Proc. Zool. Soc. Lond.,* 1879, p. 166.

[3] *Traité d'Orn.,* 1831, p. 205.

[4] *Cent. Zool.,* 1830, p. 63, pl. 18.

[5] *Abhandl. Ak. Wissensch. München,* I, 1832, p. 492.

[6] *Anal. Nat.,* 1815, p. 144.

[7] Jardine's *Contr. Ornith.,* 1852, p. 23.

[8] *Zool. Journ.,* III, Aug.–Nov., 1827, p. 354.

[9] *Phil. Mag.,* I, June, 1827, p. 440.

[10] *Phil. Mag.,* I, June, 1827, p. 440.

Xiphorhynchus palliatus (Des Murs).
Xiphorhynchus rostripallens rostripallens (Des Murs).
Xiphorhynchus rostripallens sororius (Berlepsch and Hartert).
Xiphorhynchus eytoni (Sclater).
Xiphorhynchus d'orbignianus (Pucheran and Lafresnaye).
Xiphorhynchus flavigaster flavigaster Swainson.
Xiphorhynchus flavigaster eburneirostris (Eyton).
Xiphorhynchus flavigaster mentalis (Lawrence).
Xiphorhynchus flavigaster megarhynchus (Nelson).
Xiphorhynchus striatigularis (Richmond).
Xiphorhynchus erythropygius (Sclater).
Xiphorhynchus punctigulus (Ridgway).
Xiphorhynchus triangularis triangularis (Lafresnaye).
Xiphorhynchus triangularis bogotensis (Berlepsch and Stolzmann).
Xiphorhynchus lacrymosus lacrymosus (Lawrence).
Xiphorhynchus lacrymosus eximius (Hellmayr).
Xiphorhynchus nanus nanus (Lawrence).
Xiphorhynchus nanus costiricensis (Ridgway).
Xiphorhynchus nanus confinis (Bangs).
Xiphorhynchus susurrans (Jardine).
Xiphorhynchus fraterculus (Ridgway).
Xiphorhynchus pardalotus (Vieillot).
Xiphorhynchus polystictus (Salvin and Godman).
Xiphorhynchus ocellatus (Spix).
Xiphorhynchus lineatocapillus (Berlepsch and Leverkühn).
Xiphorhynchus insignis (Hellmayr).
Xiphorhynchus elegans (Pelzeln).
Xiphorhynchus weddelli (Lafresnaye).
Xiphorhynchus kienerii (Des Murs).
Xiphorhynchus spixi (Lesson).
Xiphorhynchus chunchotambo (Tschudi).
Xiphorhynchus multiguttatus (Lafresnaye).
Xiphorhynchus obsoletus obsoletus (Lichtenstein).
Xiphorhynchus obsoletus notatus (Eyton).

XIPHORHYNCHUS Swainson

As explained under the previous heading, the generic name *Xiphorhynchus* Swainson,[1] since its type is clearly *Xiphorhynchus flavigaster* Swainson, belongs to *Dendrornis.* As the group now called *Xiphorhynchus* is thus left without a name, it may be known

[1] *Phil. Mag.*, I, June, 1827, p. 440.

as *Xiphornis,* from ξίφος, ensis, and ὄρνις, avis, and its type designated as *Dendrocolaptes procurvus* Temminck.

The species are:

Xiphornis procurvus (Temminck).
Xiphornis venezuelensis (Chapman).
Xiphornis trochilirostris (Lichtenstein).
Xiphornis thoracicus (Sclater).
Xiphornis lafresnayanus (d'Orbigny).
Xiphornis rufodorsalis (Chapman).
Xiphornis falcularius (Vieillot).
Xiphornis pusillus (Sclater).
Xiphornis subprocurvus (Reichenbach).
Xiphornis dorsoimmaculatus (Chapman).
Xiphornis pucheranii (Lafresnaye).

SHARPIA Bocage

The generic term *Sharpia,* bestowed by Bocage[1] on a group of Ploceidæ, is preoccupied in coleoptera by *Sharpia* Tournier.[2] It may be replaced by *Notiospiza,* from νότιος, meridianus, and σπίζα, fringilla.

The type is *Sharpia angolensis* Bocage; and the two species will stand as:

Notiospiza angolensis (Bocage).
Notiospiza sanctithomæ (Hartlaub).

MALACOPTERON Eyton

Doctor Sharpe has already noted[3] that *Malacopteron* Eyton is preoccupied in Coleoptera by *Malacopterus* Serville,[5] and proposes to use *Setaria* Blyth[6] in its place. Unfortunately this also is debarred, by *Setaria* Oken[7] for a genus of Vermes. The genus *Ophrydornis* Büttikofer,[8] based on *Setaria albogularis* Blyth, is quite distinct from *Malacopteron* proper, and therefore can not be employed as a substitute for the latter. Doctor Charles W. Richmond calls the writer's attention to the fact that Dr. Sharpe has recently, in seeming inadvertence, transferred this name *Ophrydornis* to the *Malacocercus*

[1] *Jorn. Sci. Math. Phys. e Nat. Lisboa,* VI, 1878, p. 258.
[2] *C. R. Ent. Belg.,* XVI, 1873, p. cxxxvii.
[3] *Bull. Brit. Orn. Club,* XII, 1902, p. 54.
[4] *Proc. Zool. Soc. Lond.,* 1839, p. 102.
[5] *Ann. Soc. Ent. France,* II, 1833, p. 565.
[6] *Journ. As. Soc. Bengal,* XIII, pt. I, 1844, p. 385.
[7] *Lehrb. d. Naturg.,* I, 1815, p. xiii.
[8] *Notes Leyd. Mus.,* XVII, 1895, p. 101.

albogularis of Blyth, which is a *Dumetia*, and at the same time left *Setaria albogularis* Blyth, the type of *Ophrydornis*, in *Malacopteron* (*Setaria*) ![1] Since in view of these circumstances it becomes necessary to provide a new name for *Malacopteron*, it may be called *Horizillas*, from ὁρίζω, limito, and ἰλλάς, turdus, with *Malacopteron magnum* Eyton as the type.

The species to be referred to this group are:

Horizillas magna (Eyton).
Horizillas cinerea cinerea (Eyton).
Horizillas cinerea bungurensis (Hartert).
Horizillas rufifrons (Cabanis).
Horizillas palawanensis (Büttikofer).[2]
Horizillas pyrrhogenys (Temminck).
Horizillas affinis (Blyth).
Horizillas notata (Richmond).
Horizillas melanocephala (Davison).
Horizillas cinereicapilla (Salvadori).

HEDYMELA Sundevall

The generic term *Hedymela* Sundevall,[3] recently employed by Dr. Sharpe for the pied flycatchers,[4] is long antedated by *Ficedula* Brisson.[5] The type of both is the same—*Motacilla atricapilla* Linnæus—and if Brissonian genera are accepted, as is now the all but universal practice, the latter name (*Ficedula*) must be used for this group. The *Motacilla atricapilla* of Linnæus,[6] moreover, must give place to *Motacilla ficedula* Linnæus,[7] a prior name for the same species. Also, the bird commonly known as *Muscicapa collaris* Bechstein[8] must be called *Ficedula albicollis* (Temminck), because *Muscicapa collaris* Bechstein[3] is preoccupied by *Muscicapa collaris* Latham,[9] a synonym of *Platystcira cyanea*, and *Muscicapa albicollis* Temminck[10] is the next available name.

The species of this genus should consequently stand as follows:

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[1] *Hand-List Gen. and Spec. Birds*, IV, 1903, pp. 27, 38, 39.

[2] This is *Trichostoma rufifrons* Tweeddale, nec *Malacopteron rufifrons* Cabanis, and is the *Turdinus rufifrons* of Sharpe, *Hand-List Gen. and Spec. Birds*, IV, 1903, p. 33.

[3] *Öfvers. Kongl. Vetensk. Ak. Förhandl. Stockholm*, 1846 (1847), p. 225.

[4] *Hand-List Gen. and Spec. Birds*, III, 1901, p. 213.

[5] *Orn.*, III, 1760, p. 369.

[6] *Syst. Nat.*, ed. 10, I, 1758, p. 187.

[7] *Syst. Nat.*, ed. 10, I, 1758, p. 185.

[8] *Gem. Naturg. Deutschl.*, IV, 1795, p. 495.

[9] *Ind. Orn.*, II, 1790, p. 471.

[10] *Man. d'Orn.*, 1815, p. 100.

Ficedula ficedula ficedula (Linnæus).
Ficedula ficedula speculigera (Bonaparte).
Ficedula semitorquata (Homeyer).
Ficedula albicollis (Temminck).

CHENORHAMPHUS Oustalet

Chenorhamphus Oustalet,[1] based on *Chenorhamphus cyanopectus* Oustalet (= *Todopsis grayi* Wallace), is rendered untenable by *Chenoramphus* Gray[2] of which the type is *Ardea oscitans* Boddaert. Since it has no other name it may be called *Conopotheras*, from *κωνωποθήρας*, muscicapa.

The type and sole species is:
Conopotheras grayi (Wallace).

HELMINTHOPHILA Ridgway

The name *Helminthophila* Ridgway,[3] long in use for a genus of Mniotiltidæ in place of the preoccupied *Helminthophaga* Cabanis,[4] must itself be supplanted by *Vermivora* Swainson[5] of much earlier date. Swainson evidently intended *Vermivora* as the generic name for *Sylvia vermivora* Wilson (= *Helmitheros vermivorus* Auct. recent.), and he so published it;[6] but in another article previously appearing, he made use of this term[7] in combination with *Sylvia solitaria* Wilson (= *Certhia pinus* Linnæus), which species therefore becomes the type of the genus. Furthermore, *Vermivora* Swainson is not, as often considered, preoccupied by "*Vermivora*" Meyer,[8] for this latter is merely a group name—"*Vermivoræ*," and not used in a generic sense at all.

The species of this genus should therefore stand as:
Vermivora chrysoptera (Linnæus).
Vermivora lawrenceii (Herrick).[9]
Vermivora leucobronchialis (Brewster).[10]
Vermivora pinus (Linnæus).

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[1] *Bull. Assoc. Scient. de France*, XXI, 1878, No. 533, p. 248.
[2] *Gen. Birds*, III, 1848, p. 562.
[3] *Bull. Nutt. Orn. Club*, VII, 1882, p. 53.
[4] *Mus. Hein.*, I, 1850, p. 20.
[5] *Phil. Mag.*, I, June, 1827, p. 434.
[6] *Zool. Journ.*, III, Apr.–July (published in July or later), 1827, p. 170.
[7] *Phil. Mag.*, I, June, 1827, p. 434.
[8] *Besch. Vög. Liv- und Esthl.*, 1815, p. 118.
[9] Probably a xanthochroic phase of *V. chrysoptera*, or a hybrid between *V. chrysoptera* and *V. pinus*.
[10] Almost certainly a leucochroic phase of *V. pinus*.

Vermivora bachmani (Audubon).
Vermivora peregrina (Wilson).
Vermivora celata celata (Say).
Vermivora celata sordida (Townsend).
Vermivora celata lutescens (Ridgway).
Vermivora rubricapilla rubricapilla (Wilson).
Vermivora rubricapilla gutturalis (Ridgway).
Vermivora virginiæ (Baird).
Vermivora crissalis (Salvin and Godman).
Vermivora luciæ (Cooper).

TIARIS Swainson

Doctor Charles W. Richmond has already shown[1] that *Tiaris* Swainson[2] belongs properly to *Euetheia,* but he failed to provide a name for the consequently nameless group of South American Fringillidæ for which *Tiaris* has commonly been employed. This, therefore, may be called *Charitospiza,* from χάρις, gratia, and σπίζα, fringilla. The type and only species, *Fringilla ornata* Wied,[3] needs a new specific designation on account of the earlier *Fringilla ornata* Vieillot,[4] and as it has no synonyms, may be known as:

Charitospiza eucosma Oberholser.

COTURNICULUS Bonaparte

An earlier name for *Coturniculus* Bonaparte[5] is found in *Ammodramus* Swainson,[6] the real type of which is *Ammodramus bimaculatus* Swainson—not, as commonly considered, *Fringilla caudacuta* Wilson (= *Oriolus caudacutus* Gmelin).[7] This is a case precisely similar to those of *Xiphorhynchus* and *Tiaris,* since the first use of *Ammodramus*[9] is in the original description of *Ammodramus bimaculatus,* the western continental form of *Ammodramus savannarum* (Gmelin), antedating by several months the publication of an article wherein *Fringilla caudacuta* Wilson is given as the type.[10]

The forms of this group will be therefore once more in possession of their former generic designation, and pass as:

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[1] *Auk,* XIX, 1902, p. 87.
[2] *Phil. Mag.,* I, June, 1827, p. 438 (type *Tiaris pusilla* Swainson).
[3] *Reis. Brasil,* II, 1821, p. 191.
[4] *Nouv. Dict. d' Hist. Nat.,* XII, 1817, p. 243 (Polynesia).
[5] *Geog. and Comp. List Bds. Eur. and N. A.,* 1838, p. 32.
[5] *Phil. Mag.,* I, June, 1827, p. 435.
[7] Cf. *Zool. Journ.,* III, Aug.–Nov., 1827, p. 348.
[8] *Antea,* pp. 62, 67.
[9] *Phil. Mag.,* I, June, 1827, p. 435.
[10] *Zool. Journ.,* III, Aug.–Nov., 1827, p. 348.

Ammodramus savannarum savannarum (Gmelin).
Ammodramus savannarum passerinus (Wilson).
Ammodramus savannarum obscurus Nelson.
Ammodramus savannarum floridanus (Mearns).
Ammodramus savannarum bimaculatus (Swainson).

AMMODRAMUS Swainson

Since the term *Ammodramus* Swainson[1] belongs to *Coturniculus,* as already shown,[2] another name is required for the group to which the former has been applied, and as there is none such available, it may be called *Ammospiza,* from ἄμμος harena, and σπίζα, fringilla, with *Oriolus caudacutus* Gmelin as the type.

The species and subspecies are:
Ammospiza maritima maritima (Wilson).
Ammospiza maritima macgillivraii (Audubon).
Ammospiza maritima peninsulæ (Allen).
Ammospiza maritima fisheri (Chapman).
Ammospiza maritima sennetti (Allen).
Ammospiza nigrescens (Ridgway).
Ammospiza caudacuta caudacuta (Gmelin).
Ammospiza caudacuta nelsoni (Allen).
Ammospiza caudacuta subvirgata (Dwight).
Ammospiza lecontei (Audubon).
Ammospiza henslowii henslowii (Audubon).
Ammospiza henslowii occidentalis (Brewster).

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[1] *Phil. Mag.,* 1, June, 1827, p. 435.
[2] *Antea,* p. 67.

HALLEY'S COMET; ITS PAST HISTORY AND 1910 RETURN

A SHORT BIBLIOGRAPHY WITH NOTES

By EUGENE FAIRFIELD McPIKE
MEMBER B. S. A., AND I. I. B., BRUSSELS

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PART 1. COMET'S PAST HISTORY

BRONTË, REV. PATRICK. On Halley's Comet, in 1835. *Popular astronomy,* 12: 571, Northfield, Minnesota, October, 1904.

A poem reprinted from *The Bradfordian,* no. 11, p. 176, Bradford, Yorkshire, England, August 1, 1861.

CHAMBERS, GEORGE F. 1841. A Handbook of descriptive and practical astronomy, 3 vols. Oxford, 1889, 1890.

Contains a cut (1:438) of a portion of the Bayeux Tapestry showing the comet of Halley, in 1066. "The comet of Halley appeared again in 1066, at the time when William the Conqueror invaded England. The chroniclers unanimously write: 'The Normans, guided by a comet, invaded England.' The Duchess-Queen Matilda, wife of William, has represented this comet and the amazement of her subjects on the tapestry (230 feet long) which may be seen at Bayeux." *See* Popular Astronomy . . . by Camille Flammarion, translated by J. Ellard Gore, p. 479, New York, n. d.

FLAMMARION, CAMILLE. Popular astronomy: a general description of the heavens, by Camille Flammarion, translated by J. Ellard Gore, New York, n. d.

"Queen Victoria has in her crown a jewel the design of which was suggested by the tail of this comet, which had the greatest influence on the victory at Hastings." (P. 479.)

FLAMMARION, CAMILLE. Astronomie populaire: description générale du ciel. 867 p. Paris, 1890. (*See* p. 609.)

GREGORY, DAVID. Astronomicæ, geometricæ et physicæ elementa. Oxford, 1702, fol. Translated into English; with additions. To which is added, Halley's Synopsis of the astronomy of comets, revised and corrected by Edmund Stone, London, 1713, 1726, 2 vols. 8vo.

This book is mentioned in the 'Bibliotheca Britannica,' by Robert Watt, vol. 1, section 439v, Edinburgh, 1824.

HALLEY, EDMOND. 1656–1742. Astronomiæ cometicæ synopsis, autore Edmundo Hallieo apud Oxoniensis geometriæ professore Saviliano, & Reg. Soc. S. *See* Philosophical Transactions . . . vol. 24, for the years 1704 and 1705, pp. 1882–1899, London, 1706.

Halley's "most celebrated work . . . was 'Astronomiæ cometicæ synopsis,' communicated to the Royal Society in 1705, and separately published in English at Oxford the same year. It was reprinted with his Tables in 1749, and translated into French by Le Monnier in 1743." (*See* Dictionary of National Biography, 24: 108, New York, 1890.)

HALLEY, EDMOND. 1656–1742. Astronomiæ cometicæ synopsis, autore Edmundo Hallieo apud Oxoniensis geometriæ professore Saviliano, & Reg. Soc. S. *See* the philosophical transactions of the Royal Society of London from their commencement, in 1665, to year 1800: abridged, with notes and biographic illustrations, by Charles Hutton . . . , London, 1809.

This abridgment gives (5: 201) only the caption of Halley's memoir, with the note following: "Dr. Halley's Astronomy of comets is here omitted, as it has been elsewhere published in a much fuller and more complete state, and that both in the English and Latin languages; as in the Miscellanea Curiosa, of Dr. Halley, in 3 volumes 8vo, in English; also translated and published in English, by G. T. Gent, in 8vo, 1757; and still more complete and perfect in Dr. Halley's Astronomical Tables, in 4to, both in Latin and English."

HALLEY, EDMOND. 1656–1742. Astronomical tables with precepts both in English and in Latin, for computing the places of the sun, moon, planets and comets. 1 vol. 4to. London, 1752.

This rare work, of which a copy is in the Hon. John S. Lawrence's private library, Grand Rapids, Michigan, was probably edited by James Bradley, successor of Halley as astronomer-royal. (*Cf. Notes and Queries,* 9th series, 11: 464.) In this book a revision of Halley's Synopsis of comets is included. (*See* Philos. Trans., abridged, Hutton, 5: 201, note, London, 1809.)

HERSCHEL, SIR JOHN F. W. Results of astronomical observations made during the years 1834, 5, 6, 7, 8, at the Cape of Good Hope; . . . London: Smith, Elder & Co., 1847. *See* chapter V., pp. 393–406.

HERSCHEL, SIR J[OHN] F.W. Observations of the comet of Halley, after the perhelion passage in 1836, made at Feldhausen, Cape of Good Hope, by Sir J. F. W. Herschel. *Memoirs of the Royal Astronomical Society;* 10: 325–335, London, 1850.

HIND, J. R[USSELL]. On the past history of the comet of Halley. *Monthly Notices of the Royal Astronomical Society,* 10: no. 3 (January, 1850) 51–58, London.

HIND, J. RUSSELL. The comets: a descriptive treatise upon those bodies . . . London: John W. Parker and Son, 1852. *See* chapter iv., 'The comet of Halley,' pp. 35–57.

LYNN, WILLIAM THYNNE. Remarkable comets; a brief survey of the most interesting facts in the history of cometary astronomy. Eighth edition, revised. 45 p. London: E. Stanford, 1900. *See* pp. 11–13.

MACLEAR, [. . . .] Observations of Halley's comet, made at the royal observatory, Cape of Good Hope, in the years 1835–1836. Read April 14, 1837. *Memoirs of the Royal Astronomical Society,* 10: 91–155, London, 1838.

MCPIKE, EUGENE FAIRFIELD. Halley's comet. *Popular Astronomy,* 12: 685, Northfield, Minnesota, December, 1904.

A note referring to Dr. Halley's discovery of the identity of the comet of 1682 known as Halley's comet.

SMYTH, *Captain* W. H. Observations of Halley's comet. *Memoirs of the Royal Astronomical Society,* 9: 229–246, London, 1836. Read June 10, 1836.

WHISTON, WILLIAM, Lectures on Sir Isaac Newton's mathematic philosophy, and Dr. Halley's account of comets. London, 1716, 8vo.

This work is mentioned in the 'Bibliotheca Britannica,' by Robert Watt, vol. i., section 961h, Edinburgh, 1824.

WINTHROP, [JOHN]. 1714–1799. Two lectures on comets; Boston, 1811.

Inside title-page, Boston, 1759. (*See* appendix, pp. 39–52.)

[. . . .] A Famous comet. *Quarterly Review,* 188: 113–138, London, 1898.

This is a very readable account of Halley's comet.

PART II. COMET'S 1910 RETURN

Astronomisches Gesellschaft. Vierteljahrsschrift. 1910 Return of Halley's comet. *Vierteljahrsschrift der Astronomischen Gesellschaft.* 39 Jahrgang, drittes Heft, pp. 149, 152, Leipzig, 1904.

Contains the announcement of a prize of 1000 Mark, offered by the Astronomisches Gesellschaft, "for the best determination of the positions of Halley's comet for the year of its return." See *The Observatory,* 28: no. 355 (March, 1905) 141.

DEMING, W. F. The meteoric shower of Halley's comet. *The Journal of the British Astronomical Association,* 12: 175–176, 288–289, London, 1902.

Relates to comet's 1910 return.

LYNN, W[ILLIAM] T[HYNNE]. Halley's comet. *Notes and queries,* tenth series, 1: 152, London, February 20, 1904.

Note referring to Pontécoulant's prediction of next perihelion passage "17 May, 1910"; also to the same astronomer's investigation as to "the position of the comet at the preceding return."

MCPIKE, EUGENE FAIRFIELD. Halley's comet. *Notes and queries,* tenth series, 1: 86, London, January 30, 1904.

Note containing an intimation that "malheureusement la tâche entreprise ne puisse pas être accomplie" by the Russian Astronomical Society, in respect of its computing bureau's proposed "calculation of the true path of Halley's comet, with a view to predicting the exact date of the next return."

PONTÊCOULANT, COUNT M. G. DE. 1766–1853. Notice sur la comète de Halley et ses apparitions successives de 1531 à 1910. *Comptes Rendus Hebdomadaires des Séances de l'Academie des Sciences,* LVIII., 706–709, 766–769, 825–828, Paris, 1864.

Pontécoulant predicts the next perihelion passage for 1910, May 16.95, Paris meridian time.

SMART, D. Halley's comet: 1910 return. *The Journal of the British Astronomical Association,* 12: 134–136, London, 1902.

[. . . .] The next return of Halley's comet. *Nature*, 11 : 286–287, London, February 11, 1875.

Note consisting of a short review of Pontécoulant's prediction of the return of Halley's comet, 1910.

[. . . .] 1910 Return of Halley's comet. *Nature*, 49 : 442, London, March 8, 1894.

" Prof. Glasenapp announces that the computing bureau established by the Russian Astronomical Society has undertaken the calculation of the true path of Halley's comet, with a view to predicting the exact date of the next return." It is said that a similar notice appeared in *Astronomische Nachrichten*, No. 3216 (1894).

Part III. Bibliographies of Dr. E. Halley.

British Museum. London. Catalogue of printed books. H. Hages, London: William Clowes and Sons, Limited, 1888. *See* cols. 273–276.

British Museum. London. Catalogue of printed books. Supplement. H-Henrivaux, London: William Clowes and Sons, Limited, 1903. *See* col. 102.

See, also, later 'accessions.'

British Museum. London. Catalogue of the printed maps, plans, and charts in the British Museum. London, 1885. *See* [vol. 1, A-K] col. 1733–1734.

C[lerke] A[gnes] M. Halley, Edmund. Dictionary of National Biography, 24 : 104–109, New York, 1890.

Biographical sketch, accompanied by a bibliography. A few corrections in the text appear in the 'Dict. Nat. Biog., 67 : Errata.'

McPike, Eugene Fairfield. Dr. Edmond Halley. *Notes and queries*, ninth series, 10 : 361–362 ; 11 : 85–86, 205–206, 366, 463–464 ; 12 : 125–126, 185, 266–267, 464–465 ; tenth series, 2 : 224.

A bibliography with notes.

Rudolph, Alexander J. and McPike, Eugene Fairfield. A Bibliography of Dr. Edmond Halley by Alexander J. Rudolph, . . . with some notes and addenda by Eugene Fairfield McPike. . . . *Bulletin of Bibliography*, Boston: Boston Book Co., June (?) 1905.

To be published.

WATT, ROBERT. Bibliotheca Britannica; or a general index to British and foreign literature, 4 vols. Edinburgh, 1824. *See* vol. 1, authors, sections 4590–460f, and vol. 3, subjects (no pagination) article Halley, Edmund.

THE ANCESTRAL ORIGIN OF THE NORTH AMERICAN UNIONIDÆ, OR FRESH-WATER MUSSELS

By CHARLES A. WHITE

The subordinal group of fresh-water mollusks, the Naiades, includes two recognized families, the Unionidæ and the Mutelidæ. These two families have many essential characteristics in common and, together, they are distinctly separate from all other molluscan families. They are not only peculiar as regards certain portions of their structure and life history but, with few exceptions, also as regards the restrictions of their inhabitation. That is, the Naiades form the great group of mollusks which are commonly known as fresh-water mussels, all of which are confined to a fresh-water habitat and all will die quickly if immersed in salt water, or if removed to the land. This article is written with special reference to the family Unionidæ, to the geographical distribution of its living representatives, and to the character and succession in time of its fossil representatives in North America. Therefore the Mutelidæ, which are far inferior in numbers and variety to the Unionidæ, and are confined to Africa and South America, will not be further referred to except in a general way. The following elementary statements concerning the structure and physiological functions of the Unionidæ are given for the purpose of emphasizing certain of the facts which are to be stated concerning the integral survival of the family through long geological ages, its present separateness from other molluscan families and the wide geographical distribution of its living members; and also to illustrate the characteristics by which the fossil shells of the family are recognized as such.

In a general way, the animal which produces, and is protected by, the shells of the fresh-water mussels is much like that of the common edible clam or, less closely, like the oyster. It is without a proper head, and also without some of the functional organs possessed by other animals; but it performs the function of locomotion, plowing slowly through mud and sand, by means of a muscular projection called the foot; that of respiration by gills, somewhat like those of fishes; that of circulation by means of a rude pulsating organ which serves as a heart; that of digestion by a stomach; and that of reproduction by minute eggs. The body, which consists of soft parts

only, is enveloped in a delicate membrane called the mantle. This organ, although so simple in structure, is a most important one, because, besides other uses to the animal, it forms the shell by secreting a milky substance which exudes, mostly from its free edges, and hardens layer upon layer, until the shells have reached their full thickness and, with the animal, their full size. It is in, or upon, the mantle also that true and valuable pearls are sometimes formed. Although these soft parts differ more or less in details of structure in different genera and species of the Unionidæ, it is the structure and texture of their shells which are generally used in recognizing their systematic relationships as well as largely in their classification; and it is of course those features and properties of the shell alone that are used in the classification of the fossil species.

In structure the shell of each individual consists of two convex valves which are generally equal in size, and of symmetrical shape. They are held together at their upper edges by a horny ligament, and are also drawn together by the two strong muscles of the animal within. Their joined edges under the ligament are usually provided with interlocking projections, the so-called hinge teeth, but some have no such teeth. The free, or lower, edges of the valves open a little way, and it is upon the forward portion of these edges that the shell rests when it is in its natural position.

The shell-substance consists of three distinct layers, each being of different quality and texture. First, a more or less thick inner pearly layer, which is usually iridescent and often of beautiful tints; second, a very thin vertically prismatic layer outside of, and firmly adhering to the pearly one; and, third, outside of all, a thinner horny layer, called the epidermis. This shell-structure is the same for all the members of the Unionidæ in all parts of the world, and it was the same for all members of the family that have existed in former geological ages, as is shown by their fossil remains.

Although the family characteristics of the Unionidæ, in whatever part of the world they are found, are clearly defined by structure and shell-texture, the species and genera in certain great regions are distinctly different from those of other regions. The family is of world-wide distribution, representatives of it being found in the fresh waters of all the continents, in those of all the large islands, and in those of some of the smaller sea-girt islands. The number of known species of the family now living in the whole world is about one thousand. Of this number about six hundred species live in North American waters, and of the latter number the Mississippi River system alone contains about four hundred, or about four tenths of all the known species in the world.

While the species and genera of the Unionidæ are different in different regions, the family is so distinct from all other molluscan families except the Mutelidæ that naturalists, reasoning from present physical conditions and biological data only, have generally assumed for it a common genetic origin in some one region, its subsequent differentiation, and its final distribution to other regions. Because of the fresh-water requirements of those mollusks and the separation by marine waters of the regions which they occupy, and also because there are many cases of intracontinental restriction of regional areas of distribution, the question, how the great distribution of the family could have occurred has been a most perplexing one. The marine waters of the earth cover the larger part of its surface and they are everywhere continuous and of essentially the same character. It is therefore easy to understand how any family of marine animals might gain a universal distribution by successive migrations; but the case is very different with the Unionidæ. Since every member of that family dies quickly if placed in sea water or upon land they are confined to rivers and brooks, lakes and ponds and they cannot by their own act pass from one congenial habitat to another, either overland or through marine waters. Voluntary migration from one region to another being out of the question, some method of distribution by agential transportation has been generally advocated. Local dispersion by the shifting of drainage lines has been suggested; and even the independent origination of members of the family in each region has been assumed. It is desirable to give some account of the views which have been held concerning the geographical distribution of the Unionidæ, both for completeness of statement and for the purpose of comparing those views with the hypothesis concerning the geological origin of the North American species which I shall propose.

Those who have suggested the distribution of the family by transportation have attributed it to the agency of birds and fishes respectively. For all such cases it has been assumed that it was the eggs, or the newly hatched fry, technically called the glochidium, or the byssus-bearing fry, and not the adult mollusks, that have been transported. Immediately after the fry have been hatched from the eggs, and while they are exceedingly minute, some, if not all of the species develop hooklets upon the temporary shell by which each can attach itself to other objects. At a later stage the fry attaches itself to other objects by a slender, thread-like byssus.[1] It has been thought that these larval mollusks may become attached to, or

[1] I make this statement from personal observation many years ago.

entangled upon, the feet of aquatic birds and carried by them in their flight from the fresh waters of one region to those of other regions and there set free. This suggestion seems to be plausible but no known migratory range of aquatic birds will connect any considerable part of the regions of the earth which the Unionidæ are known to inhabit. Besides this all the species, and even the genera, of those mollusks which live in certain of the widely separated regions are different from those of other regions, and those differences are not accounted for in the supposition that the one region was stocked from the other. Moreover, very little interchange of species seems to have occurred under primeval conditions in certain of the intracontinental regions which are constantly visited and revisited by aquatic birds. For example, the Mississippi and St. Lawrence river systems closely approach each other by some of their head waters, and yet each system originally contained a very different Unione fauna from that of the other, although the annual migratory range of millions of aquatic birds has for centuries traversed both regions. It is true that a small number of species are now known to inhabit both of those river systems, most of which probably owe their double habitat to the agency of man. It is also likely that the traffic-canals which are now constructed or projected will increase the number of emigrants from each fauna.

The suggestion that fishes have been instrumental in the distribution of the Unionidæ refers to the glochidia, or minute fry, before mentioned. It is well known that these minute larval mollusks attach themselves to fishes which live in the same waters, and that they burrow into their skin, where they become hermetically encysted for further development. Migratory fishes coming from the sea into fresh waters to spawn may thus become infested if the spawning season of the mollusks and fishes should be approximately coincident. If such fishes should return to the sea bearing in their skins the hermetically encysted parasites, and then enter another river with them, it has been thought that the young mollusks might escape into the new congenial waters and stock them with their kind. Unfortunately for this suggestion the encysted term for the young mollusk is only about seventy days, while the fishes would not naturally return from the sea to fresh waters before the spawning season of another year. Even then they would be much more likely to return to the same river again than to enter any other. Long before that time the young mollusks would have dropped from their cysts and died in the salt water.

The suggestion that the dispersion of the Unionidæ has been

effected by changes in the direction of drainage, caused by physical changes in the land surface, seems to be applicable to certain cases, but it is of course not of general application. For example, the Upper Mississippi and the Red River of the North have a closely similar Unione fauna, although the one empties into the Gulf of Mexico and the other into the Arctic Ocean. Their head waters are now far apart, and the land surface between them has only slight elevation. This suggestion is pertinent to the hypothesis which I shall present concerning the survival of the Unionidæ through successive geological periods.

Only one more of the suggestions that have been offered in explanation of the manner in which the present distribution of the Unionidæ has been accomplished will be noticed. Indeed, this one is of so improbable a character that it is presented only to show what extreme views have been held upon this subject. This suggestion is that the Unionidæ of every river system which they inhabit originated independently from somewhat similar molluscan forms that existed in marine waters near the river mouths, that those mollusks entered the rivers, acquired the characteristics of the fresh water family, and differentiated into new species and genera. If one should consider this suggestion seriously it may be remembered that many of the rivers which contain closely similar Unione faunas flow into arctic and tropical seas respectively, and that the molluscan faunas of those seas are correspondingly different. Also that some of the rivers which contain species of the Unionidæ and other fresh water gill-bearing mollusks flow into inland seas, the character of whose waters is such that no molluscan life can exist in them. Such, for example, as the Jordan, flowing into the Dead Sea, and the Bear and Utah rivers flowing into Great Salt Lake. The primary origin of fresh water mollusca from certain marine forms that became land-locked in local waters which gradually freshened as the surrounding land was elevated above sea-level, is of course admitted. But that a distinct and well characterized family of fresh water mollusks could have originated from among incongruous marine faunas at a multitude of distinctly separated centers, and entered the rivers by self migration, is not to be accepted as a rational proposition.

The attempts that have been made to explain the manner in which the present distribution of the Unionidæ has been accomplished are not only defective from a biological point of view, but none of them has had special reference to fossil Unione faunas. I shall presently show what I regard as good evidence that certain North American

fossil faunas are ancestrally related to the living fauna of the Mississippi River; and by inference that other living faunas had a like ancestral origin.

Of late years students of the living North American Unionidæ have recognized among the abundant species a considerable number of genera; properly basing their determinations largely upon the structure of the animal itself as well as upon that of the shell, and also to some extent upon group-differences that were formerly much overlooked. The earlier North American naturalists, however, classifying those mollusks by means of the shells alone, usually recognized only three genera, namely, *Unio, Anodonta* and *Margaritana* or *Alasmidonta,* many of them having regarded the latter name as only a synonym of *Margaritana.* In studies of the fossil Unionidæ one is necessarily confined to the shells alone; and the fossil material which is available is usually insufficient for the recognition of such groups of species as are recognizable among living faunas. Because of these facts, and partly from a long established habit, I have retained that older classification in my studies of the fossil species. As the character of this article does not really require it, I do not now make any special reference to the improved classification.

Although the Mississippi fauna contains about four hundred species only about a dozen of them are referred to the genus *Anodonta.* Their preferred habitat is in still waters apart from the two other genera, and their shells are all of plain, simple type. The species that are referable to the genus *Margaritana,* including *Alasmidonta,* in the same fauna are less in number than are those of *Anodonta.* They live in immediate association with *Unio,* and their shells have considerable diversity of form and surface features. It is therefore almost only among the teeming species of *Unio* that occurs the great variety of form and surface features by which the shells of these mollusks have given expression to what naturalists have long recognized as North American types of the Unionidæ. I shall show that this term is properly so applied, not only because these Mississippi River types are different from those which are found among the living members of the family in other parts of the world, but because they evidently have been derived from ancient North American ancestry. The illustrations upon the accompanying plates express this prototypal character of the fossil species, so far as is practicable by such means, with the aid of the material that has hitherto been discovered.[1] It is only claimed that the expression

[1] The specimens from which these figures were drawn are all the property of the U. S. National Museum.

given by these illustrations is of a general character, but one who is familiar with the living fauna of the Mississippi River will not fail to recognize a close similarity of some of its members to certain of the fossil species. Full artificial expression of the general relationship that exists between these fossil species and those which are now living in the Mississippi River system would require a large number of figures of the living, as well as of the fossil, species. As such a full illustration is, for obvious reasons, not now practicable, the reader is referred to the publications mentioned below[1] or, better still, to the mollusks themselves in their native waters.

Before proceeding with special references to the figures upon the accompanying plates and to the fossil species which they represent, some explanation of relevant paleontological and geological facts in their relation to ancient physical geography is necessary. For the sake of brevity these explanatory remarks are mostly made in sentential, rather than in strictly consecutive, form.

Fossil shells of the Unionidæ have been discovered in great numbers and variety in many parts of the world and in formations of various geological periods. They are found imbedded in more or less hardened rocky strata that originally consisted of muddy or sandy sediment at the bottom of bodies of fresh water. Those lacustrine waters were finally shifted to other areas by oscillations of land surface or drained away by the deepening of the channels of outlet, but they left an unmistakable record of their fresh-water character in their fossiliferous sediments, which remained. So restricted are the living Unionidæ to fresh waters, and so distinctive are the shell characters and the shell texture of all the members of the family, that the geologist is as certain that the strata containing their fossil remains were deposited in fresh, and not in marine, waters as if he had then been there and analyzed them. Moreover, there are usually found with the fossil shells of the Unionidæ the shells of other mollusks which are similar to those of the associates of their living congeners.

The existence of a lake, or a body of fresh water, implies the coexistence of a surrounding land surface upon which flow drainage streams of inlet and outlet. The existence of a stratified deposit or formation containing remains of fresh water mollusks implies that the

[1] Observations on the Genus Unio. By Isaac Lea. Vols. I–XIII quarto. Profusely illustrated by full-page plates, part of which are colored.

Synopsis of the Naiades, or pearly fresh-water Mussels. By Charles Torrey Simpson. *Proc. U. S. National Museum,* vol. XXII, pp. 501–1044, and plate XVIII. The literature of the Unionidæ is very extensive. That for North America is catalogued by Mr. Simpson in the forementioned work.

deposit was made in lacustrine waters, and that such a surrounding land surface as that just mentioned existed at the time the deposit was made. The study of North American geology has revealed the presence, especially in the broad interior region of the continent, of many such lake deposits containing remains of the Unionidæ, the earliest one of which that will be referred to being of Triassic age. These deposits alternate with marine formations, showing that the continent has risen by repeated oscillations of the land surface with relation to sea-level, and not by one uniform upward movement extending through successive geological ages. The aggregate gain of these oscillatory movements is the present elevation of the continent.

The first land that appeared above sea-level was drained of its surface waters by brooks; and as the land increased in extent the waters of the brooks increased in volume and became rivers. The unequal elevation of continental land occasionally caused broad depressions of its surface, which filled with drainage water and became lakes. Each lake, together with its outlet and inlets, became stocked with a fresh water fauna which was derived from some pre-existing fauna. Because all existing lakes and rivers contain molluscan life, and because all lacustrine deposits contain remains of such life, it is necessarily inferred that formerly existing lakes and rivers were stocked in like manner.

Lakes are parts of unfinished river systems. The deepening of the outlet portion of such a river system by its running water, aided by sedimentation in the still water, drains the lake and finishes the river system. For example, referring to existing rivers, all parts of the Mississippi system are finished except the slight expansion called Lake Pepin. The St. Lawrence system is very far from finished because of the great, and many smaller, lakes that still remain in both its principal and subordinate courses.

As a rule, abrupt land elevations, including mountain ranges, which have resulted from foldings and other displacements of the earth's crust, have risen so slowly from previously plain regions, that the rivers which were already established there were not only not thereby obliterated, but usually they were not even materially deflected from their courses. By the corrasive action of its running water and the detritus which it carried by its flow, each stream abraded and carried away the earth-material, even including solid rock, as it slowly rose beneath its channel. Some of the now existing rivers have thus made deep cañons with precipitous sides, through the rocky strata of elevated regions, and some have even cut their way through mountain ranges. The cañon sides represent

the rising of the land, not the lowering of the river. The cañon of Green river through the Uinta mountain range, and the Grand Cañon of the Colorado of the West through the Great Plateau, are cases of this kind. Still, some rivers have suffered vertical displacements in at least parts of their course. For example, the prolongation of the channel of some existing rivers of North America, is traceable by soundings beneath sea-level, where they sank by subsidence of the continental border. If that border should be raised again such rivers and their faunas would come into their former possessions. At the beginning of the Tertiary period the Upper Mississippi and Ohio rivers emptied separately into the Gulf which then extended northward above the present confluence of the two rivers. That is, the whole of what is now the Lower Mississippi was then beneath sea-level. It has since been added to the upper portion of the great river system and stocked with its fauna.

These, and many other similar facts show that rivers, once established, although often modified in extent by land elevations and subsidences, and changed in direction by the opening of new lake outlets, have been among the most persistent features of the earth's surface. The lakes which occupied portions of the course of ancient rivers have all been obliterated; and doubtless also in rare cases some rivers or small river systems, with their molluscan faunas, have been wholly destroyed. The facts which have been stated, however, warrant the assumption that, as a rule, some portions of those ancient rivers have preserved a continuous flow of fresh water to the present time. I do not doubt that at least some portions of the present Mississippi River system represent a continuous fluvatile flow from a time at least as remote as the Cretaceous period. Rain waters have always fallen upon the land ever since its first elevation above the sea, and a constant flow of drainage streams has been necessary to remove it. It is only by a constant flow that genetic lines of fresh water denizens could have been preserved; and I therefore assume that the Unione fauna of the Mississippi River system has in this way been, at least in part, genetically derived from the fossil faunas some of whose remains are figured on the accompanying plates.

Some of the types of former fresh water denizens whose remains have been discovered are not found among living faunas, and it is therefore inferred that these were among the faunas of those rivers which failed entirely to preserve their continuity of flow through successive geological periods. For example, although *Unio belliplicatus,* which is represented by figures 4, 5 and 6, on plate

XXVIII, has all the structural and textural characteristics of the genus *Unio,* it is not only the earliest known species of that genus to possess well marked surface ornamentation, but its type of ornamentation is different from that of any known living North American species. Besides this, several species of the gasteropod mollusks which are associated with this *Unio* are also different in certain characteristics from any of their kind upon this continent, either fossil or living. Moreover the Bear River formation, in which this fossil fauna is found, is of small extent compared with the other North American fresh water formations. From all these facts I infer that the body of water in which the Bear River beds were deposited, together with its inlets and outlet, constituted a small separate river system with a distinctive fauna. Also that its case was an exception to the rule of the persistence of the rivers, and that this whole small river system with its fauna became destroyed by some geological disturbance of the land surface. The types of the Bear River fauna which were not thus destroyed, for example, the simple type of *Unio nucalis,* which existed before, and have existed ever since the Bear River epoch, were probably preserved in other bodies of fresh water by collateral lines from an original genetic source. These remarks upon ancient physical geography may be closed with the following summary statements, together with references to the figures upon the accompanying plates and to the species which they represent.

Fresh-water gill-bearing faunas have as certainly descended genetically through successive geological ages to the present time as have marine faunas. The genetic successors of each fauna have necessarily descended in a continuous fresh-water habitat. Such continuity of habitat has been produced and preserved by the seasonal rains which have always fallen upon the land and caused a constant drainage flow in its rivers and their branches. There has never been any intermission of such continuity because the fresh water supply has never failed, and because, as a rule, rivers have been among the most persistent of the earth's surface features. While some rivers, or small river systems, have doubtless been from time to time destroyed by certain special movements of the earth's crust and their peculiar faunas utterly exterminated, it is not probable that through all the great vicissitudes of continental develment any greater proportion of fresh-water types have been thus destroyed than of marine types which have perished by volcanic eruptions, local elevation or depression of sea-bottom, changes of sea-currents, and other causes.

Measured geologically, the life-time of species as such has been short, but genera, and the types which they embrace, have persisted through successive geological ages. The types of *Unio* which are represented on the accompanying plates have been thus preserved, while the species which successively bore them became extinct in the successive geological opochs. They so much resemble certain members of the living Mississippi river fauna as to warrant the assumption that the fossil faunas represent the living fauna ancestrally.

Many specimens of fossil shells of the Unionidæ have been discovered in the Triassic strata of New Mexico and Wyoming. All of them are very imperfect and of comparatively small size, but they unmistakably belong to the genus *Unio*. One of these Triassic specimens is represented by figure 1, plate XXVI. The specimens referred to are the earliest of the certainly known examples of the Unionidæ in North America, although certain shells found in Devonian and Carboniferous rocks have been supposed to belong to that family. These Triassic shells are all of simple form, and none of them exhibits distinctive prototypal relationship to the living Mississippi River fauna. Their structure and shell texture, however, clearly show that the genus *Unio* was fully established at that early period; and their wide distribution indicates that a large Unione fauna was then established.

In all, seven species of the Unionidæ have been discovered in the fresh water Jurassic strata of Colorado, Wyoming and South Dakota. All of them belong to the genus *Unio*, and five of the seven species are represented on plates XXVI and XXVII. They are all of simple, plain types, none of them exhibiting any special relationship to the Unione fauna of the Mississippi, unless it be *U. stewardi*. It is, however, not improbable that all these species, as well as those found in Triassic strata, are ancestrally related to the simpler forms of the Mississippi fauna.

While there evidently was a large representation of the Unionidæ in the Triassic and Jurassic periods, it was in the closing period of Mesozoic time, the Cretaceous, that the family received an extraordinary development. This fact is shown by the discovery at numerous places within a large geographical area, and in several successive formations, of a large number and great variety of fossil species of *Unio*, and of the addition among them of a few species of *Anodonta* and *Margaritana*. The increased diversity of the Unionidæ in this period is also shown in the exhibition by many of the species of *Unio* of those peculiarities which I have designated

as North American prototypal characteristics. These discoveries of Cretaceous species have been made in the states of Colorado, Utah, Wyoming, South Dakota and Montana; and in the Canadian territories of Alberta, Assiniboia and Saskatchewan. In vertical range these discoveries extend from the base to the top of the Cretaceous series of formations as it exists in the great region just indicated. The formations, or groups of strata, are, beginning with the lowest, the Dakota, Colorado, including the Bear River beds, Pierre, including the Fox-Hills, Judith River and Belly River beds, and the Laramie. The Dakota group has furnished comparatively few molluscan fossils, and the most that need now be said of it is that it is not of marine origin. The Colorado and Pierre formations consist mainly of unquestionably marine strata, with which the fresh water groups alternate. The Laramie is the uppermost formation of the Cretaceous series and the character of its molluscan fauna gives evidence that it was deposited in a body of water that was in part fresh and in part brackish. This formation aso contains plant remains which have been referred to the Tertiary; and dinosaurian remains which are regarded as of Cretaceous age. I now provisionally refer the formation to the latter age, although its molluscan fauna might with propriety be referred to the Tertiary. It is in the Laramie strata that the greatest number of species of *Unio* have been found that bear the prototypal features which have been frequently referred to. Most of these species were found in a few fossiliferous layers of limited extent, each of which was probably deposited near the mouth of an inlet and not in the stiller waters of the lake. The formation from which each of the species represented upon the accompanying plates were obtained is noted upon the page of explanations which accompanies each of the plates.

Besides the species which are referred to in the foregoing paragraphs and figured on the accompanying plates, Professor R. P. Whitfield has published descriptions and figures of six new species of *Unio* which were discovered in strata of the Laramie Group of Montana, and which he has named as follows: *Unio æsopiformis, U. verrucosiformis, U. retusoides, U. browni, U. percorrugata,* and *U. postbiplicata.* All these fossil species present prototypal characteristics of the living Mississippi Unione fauna in a marked degree. Three of them are so closely like three living species respectively that Professor Whitfield has given names to the fossil

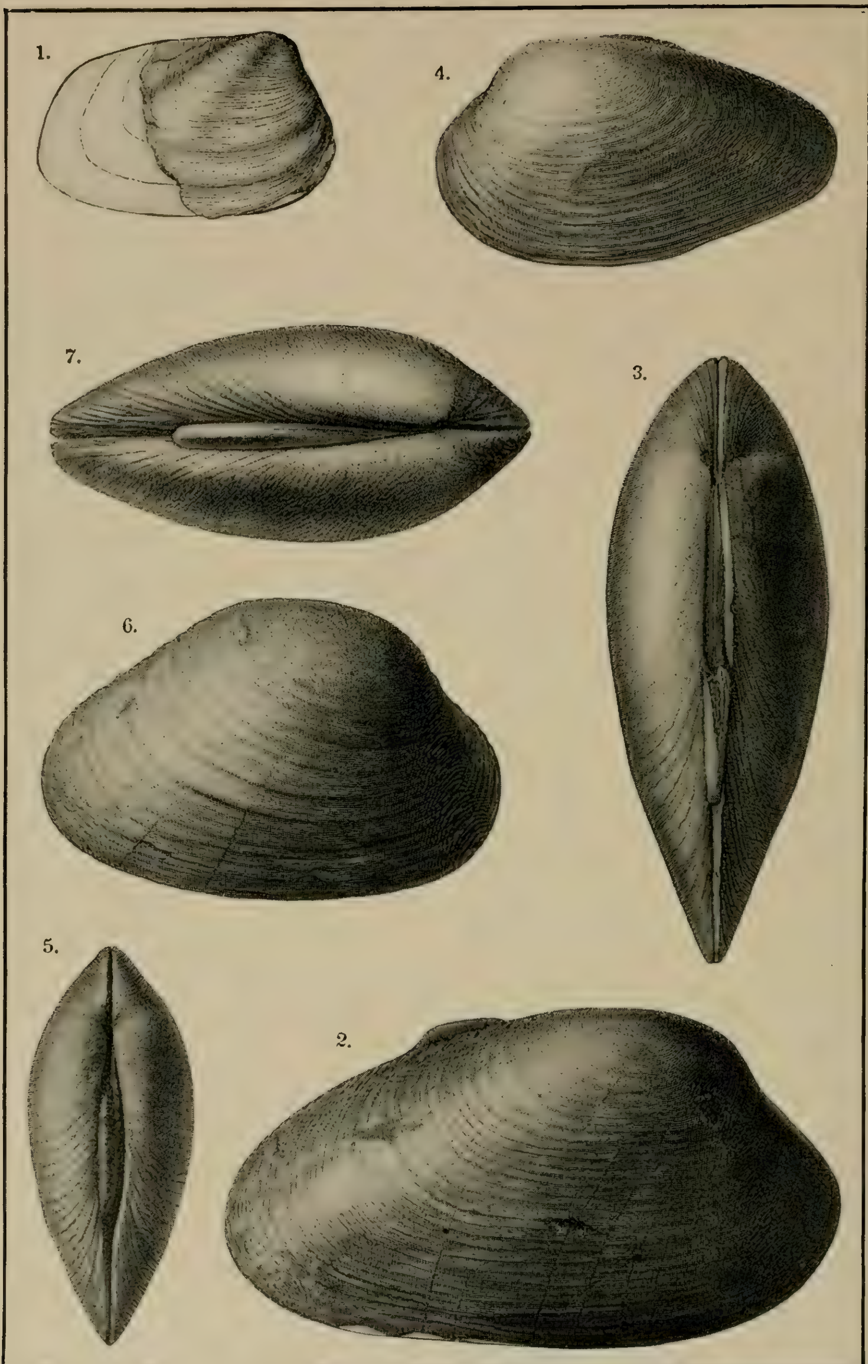
[1] "Notice of Six New Species of Unios from the Laramie Group," by R. P. Whitfield, *Bull. Am. Museum of Nat. Hist.*, vol. XIX, pp. 483–487, plates XXXVIII–XL.

forms which are only modifications of the names of the living forms which they so closely resemble. One cannot doubt that further discoveries will yield additional evidence of the prototypal relationship of the fossil and living Unione faunas of this continent.

Following the Laramie in the order of time and of geological sequence, are the Eocene, Miocene and Pliocene Tertiary formations, all three of which, in the great interior region of North America, consist of fresh water lacustrine deposits. From the fact that the Laramie Group has been found to contain so many prototypal examples of the North American Unionidæ one might naturally expect to find among the Tertiary molluscan faunas numerous species of *Unio* that would, by similar prototypal features connect the Laramie forms more or less directly with the living Mississippi River fauna. Such, unfortunately, is not the fact, for only a few species of the Unionidæ have been found in any of those Tertiary deposits, and they are all of simple type and plain surface. If only such plain forms of *Unio* really existed in those Tertiary waters between the Laramie period and the present time, my assumption of the ancestrally prototypal character of the Cretaceous Uniones would be unsupported. Without any exception known to me, however, the strata in which the Tertiary Uniones have been found show evidence of having been deposited in comparatively still lacustrine waters, and it is a well known fact that one rarely, if ever, finds any other than plain types of the living Unionidæ in the still waters of lakes. The more diverse and ornamental forms of living Uniones occupy fluvatile, or other running or moving waters. None of the deposits containing the Tertiary Uniones referred to gives any inherent evidence of having been formed in fluvatile or estuarine waters, but such deposits were doubtless made somewhere in the tributaries, and upon the borders, of those Tertiary lakes. When such deposits are discovered they will doubtless be found to contain North American prototypal forms, such as will connect the Cretaceous types with those of the Mississippi River fauna.

When referring in a previous paragraph to the diverse views which have prevailed among naturalists concerning the present geographical distribution of the Unionidæ, it was intimated that any discussion of this question ought to have reference to the fossil Unione faunas of the respective regions. I have shown what I regard as good evidence that the well known types of North American Uniones in the fauna of the Mississippi River have descended genetically from North American fossil faunas; but I am not yet prepared to offer an explanation of the geographical distribution of the Unionidæ in the various regions of the world.

The accompanying illustrations, plates XXVI to XXXI, are all of natural size and all the specimens are the property of the U. S. National Museum. An explanation of the figures faces each plate.



UNIONIDÆ

PLATE XXVI

Unio cristonensis Meek. Triassic.

FIG. 1. Imperfect right valve; part of the outline restored.

Unio felchii White. Jurassic.

FIG. 2. Right side view; probably a female.
FIG. 3. Dorsal view of the same specimen.
FIG. 4. Left side view of a younger specimen; probably a male.
FIG. 5. Dorsal view of the same specimen.

Unio toxonotus White. Jurassic.

FIG. 6. Right side view of an adult specimen.
FIG. 7. Dorsal view of the same.

Plate XXVII

Unio stewardi White. Jurassic.

Fig. 1. Left side view; restored from broken specimens.
Fig. 2. Left side view of a younger specimen.

Unio nucalis Meek and Hayden. Jurassic.

Fig. 3. Left side view.
Fig. 4. Dorsal view of the same specimen.

Unio mecropisthus White. Jurassic.

Fig. 5. Left side view.

Unio iridoides White. Jurassic.

Fig. 6. Right side view.

Margaritana nebrascensis Meek. Dakota group of the Cretaceous series.

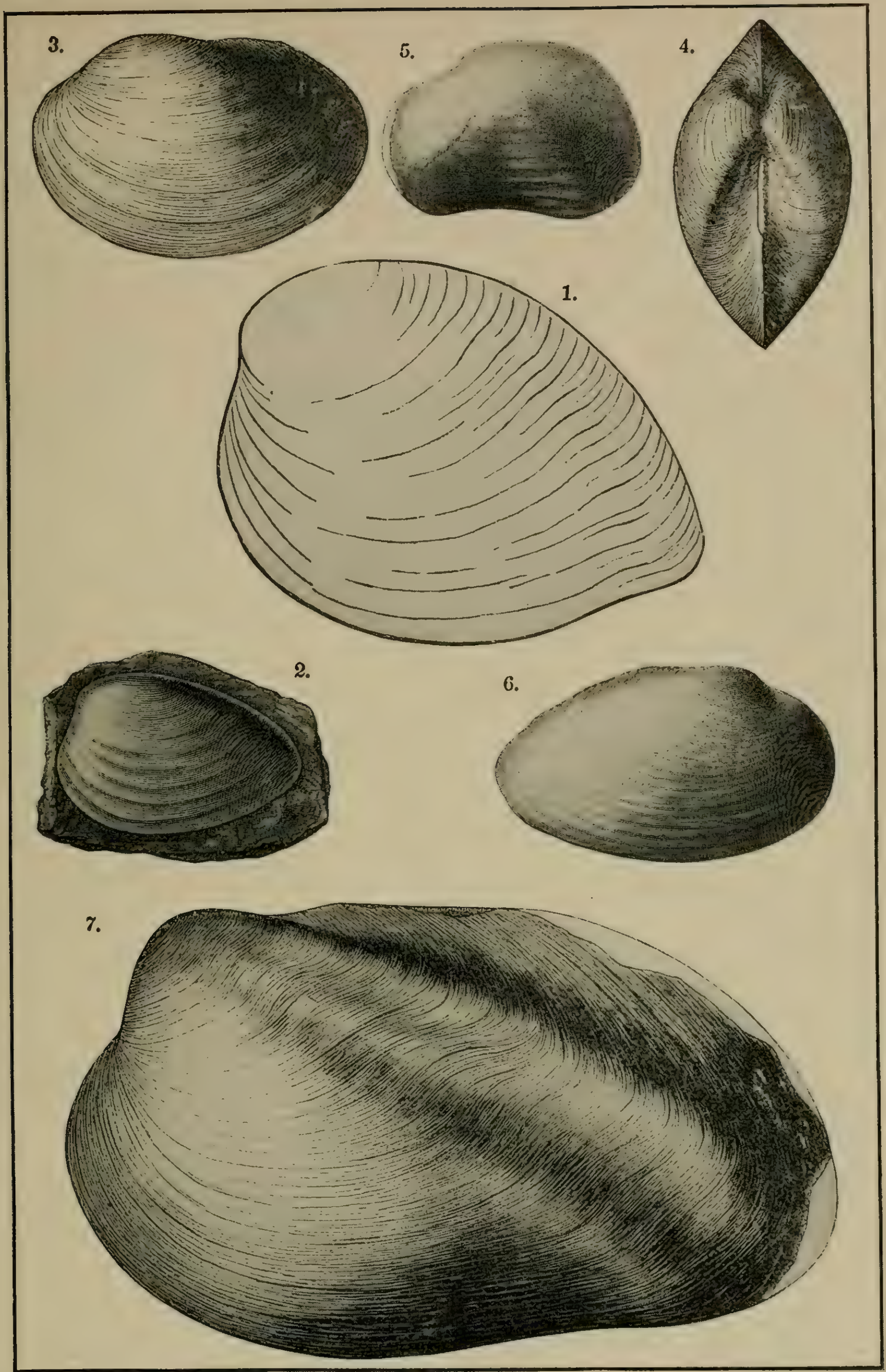
Fig. 7. Left side view.

The species, *U. stewardi* resembles a common type of *Unio* in the Mississippi fauna.

The figured specimen of *U. macropisthus* is the only one discovered. Its posterior breadth probably indicates that it is a female.

The species, *U. iridoides,* closely resembles *U. iris,* of the Mississippi fauna.

Margaritana nebrascensis is much more inflated, especially in the umbonal region than is any known living species of that genus; but it is known to possess the hinge structure of *Margaritana.*



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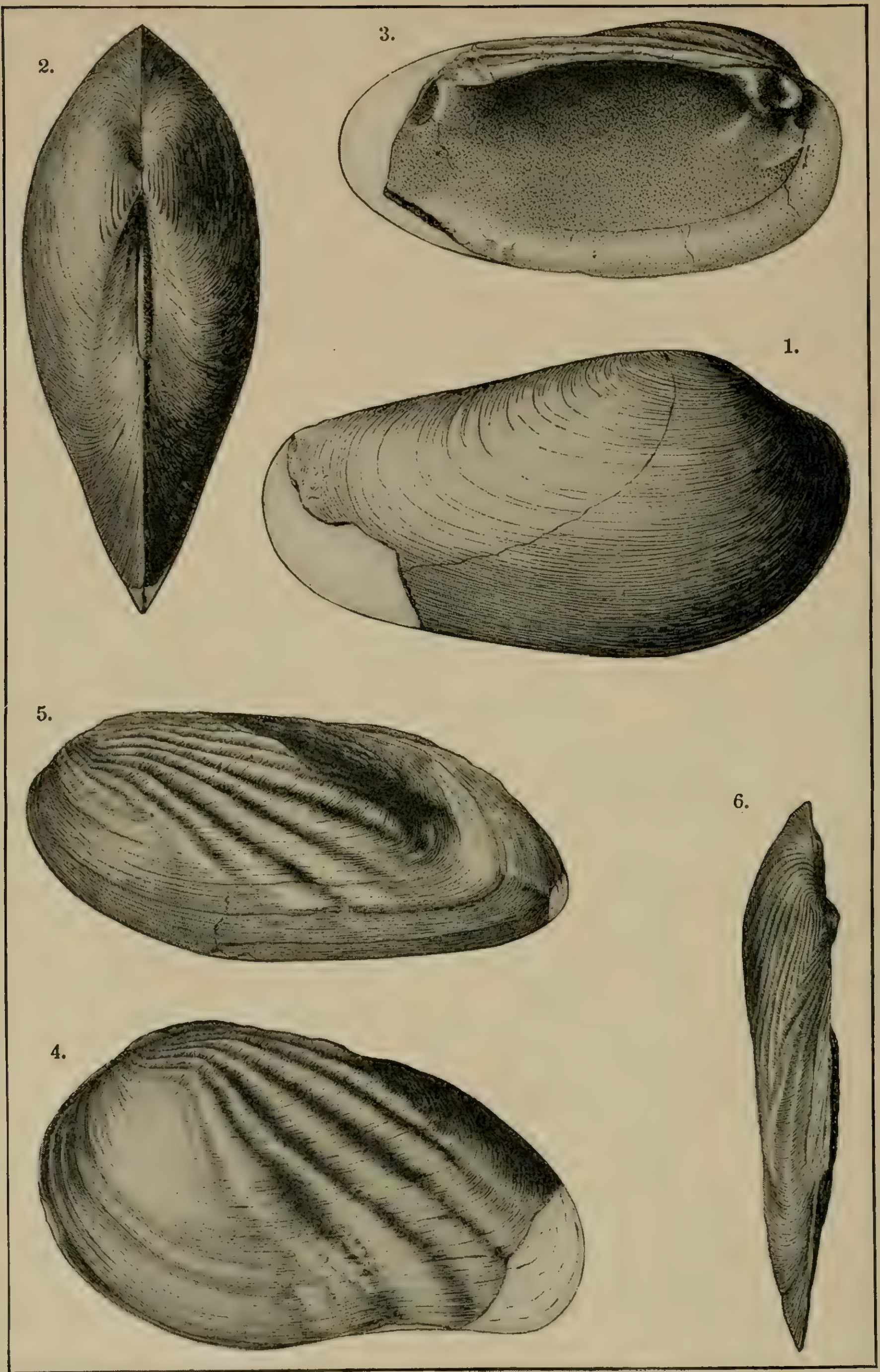


UNIONIDÆ

PLATE XXVIII

Unio vetustus Meek. Bear River beds of the Cretaceous series.

FIG. 1. Right side view of probably a male specimen.
FIG. 2. Dorsal view of the same specimen.
FIG. 3. Interior view of a left valve.

Unio belliplicatus Meek. Bear River beds of the Cretaceous series.

FIG. 4. Left side view of probably a male specimen.
FIG. 5. Left side view of probably a female specimen.
FIG. 6. Dorsal view of a left valve, showing beak sculpture.

Plate XXIX

Unio endlichi White. Laramie group of the Cretaceous series.

Fig. 1. Right side view of a large specimen.
Fig. 2. Interior view of a smaller, left valve.

Unio propheticus White. Laramie group of the Cretaceous series.

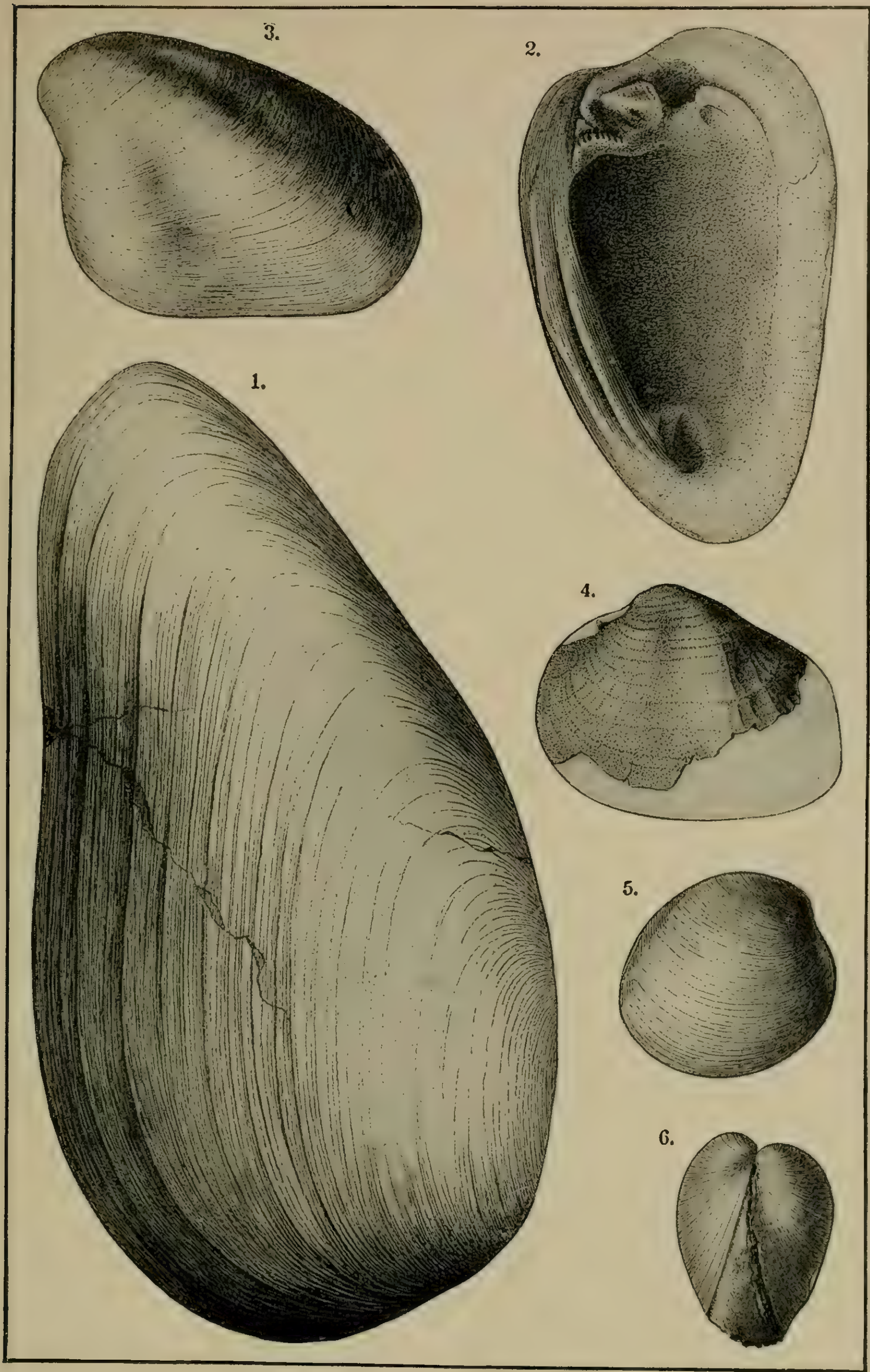
Fig. 3. Left side view.

Unio primævus White. Judith River beds of the Cretaceous series.

Fig. 4. Left side view of a broken specimen.

Unio brachyopisthus White. Laramie group of the Cretaceous series.

Fig. 5. Right side view of a small, probably a young, specimen.
Fig. 6. Front view of the same.



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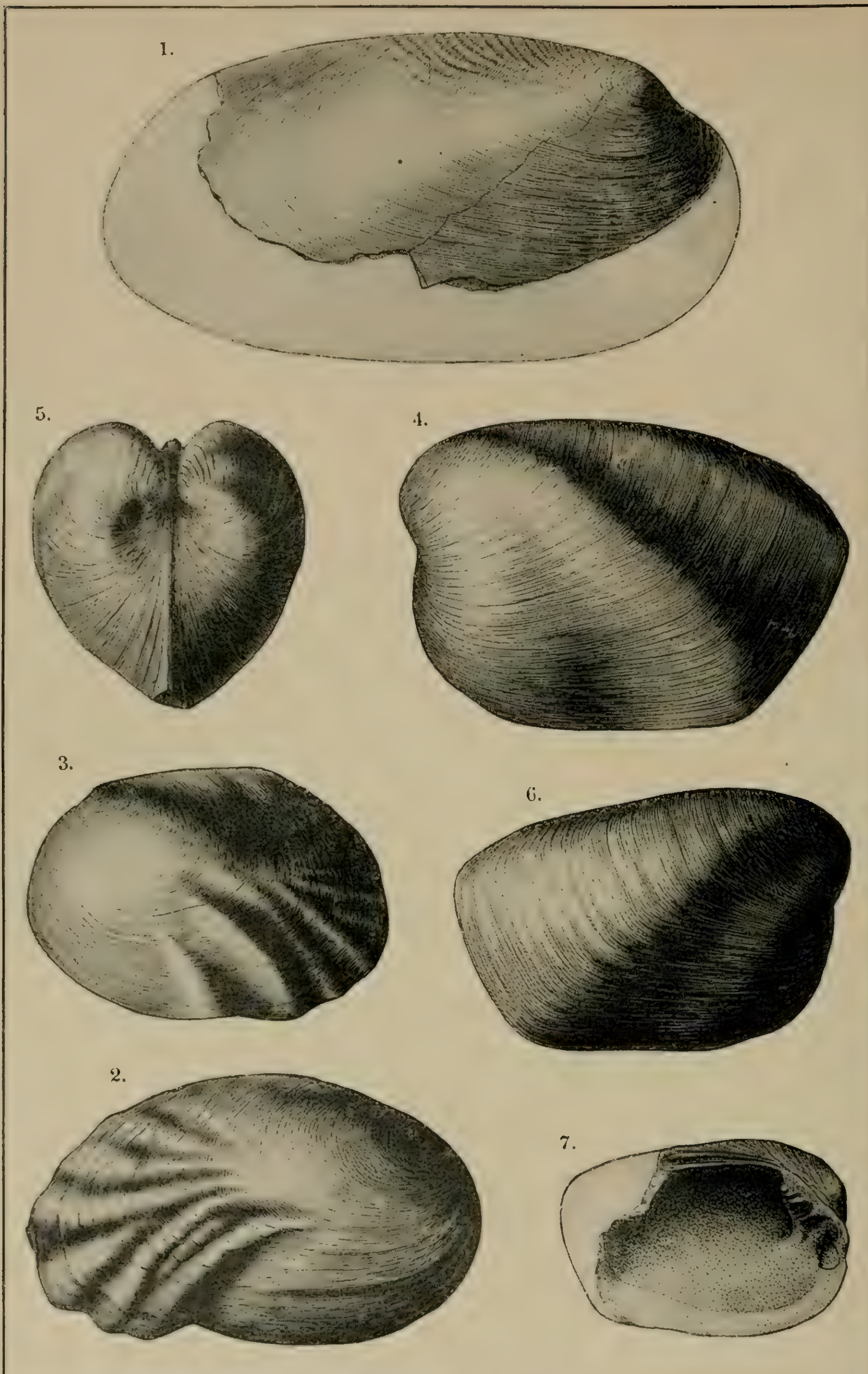


UNIONIDÆ

PLATE XXX

Unio senectus White. Judith River beds of the Cretaceous series.

FIG. 1. Right side view of a broken specimen.

Unio gonionotus White. Laramie Group of the Cretaceous series.

FIG. 2. Right side view of an adult specimen.

FIG. 3. Left side view of a younger one.

Unio proavitus White. Laramie Group of the Cretaceous series.

FIG. 4. Left side view of an adult specimen.

FIG. 5. Front view of another adult.

FIG. 6. Right side view of another specimen.

FIG. 7. Interior view of a left valve.

Plate XXXI

Unio aldrichi White. Laramie Group of the Cretaceous series.

Fig. 1. Left side view of a partially broken specimen.

Fig. 2. Dorsal view of the same.

Unio holmesianus White. Laramie Group of the Cretaceous series..

Fig. 3. Left side view of an adult specimen.

Fig. 4. Dorsal view of the same.

Unio goniambonatus White. Laramie Group of the Cretaceous series.

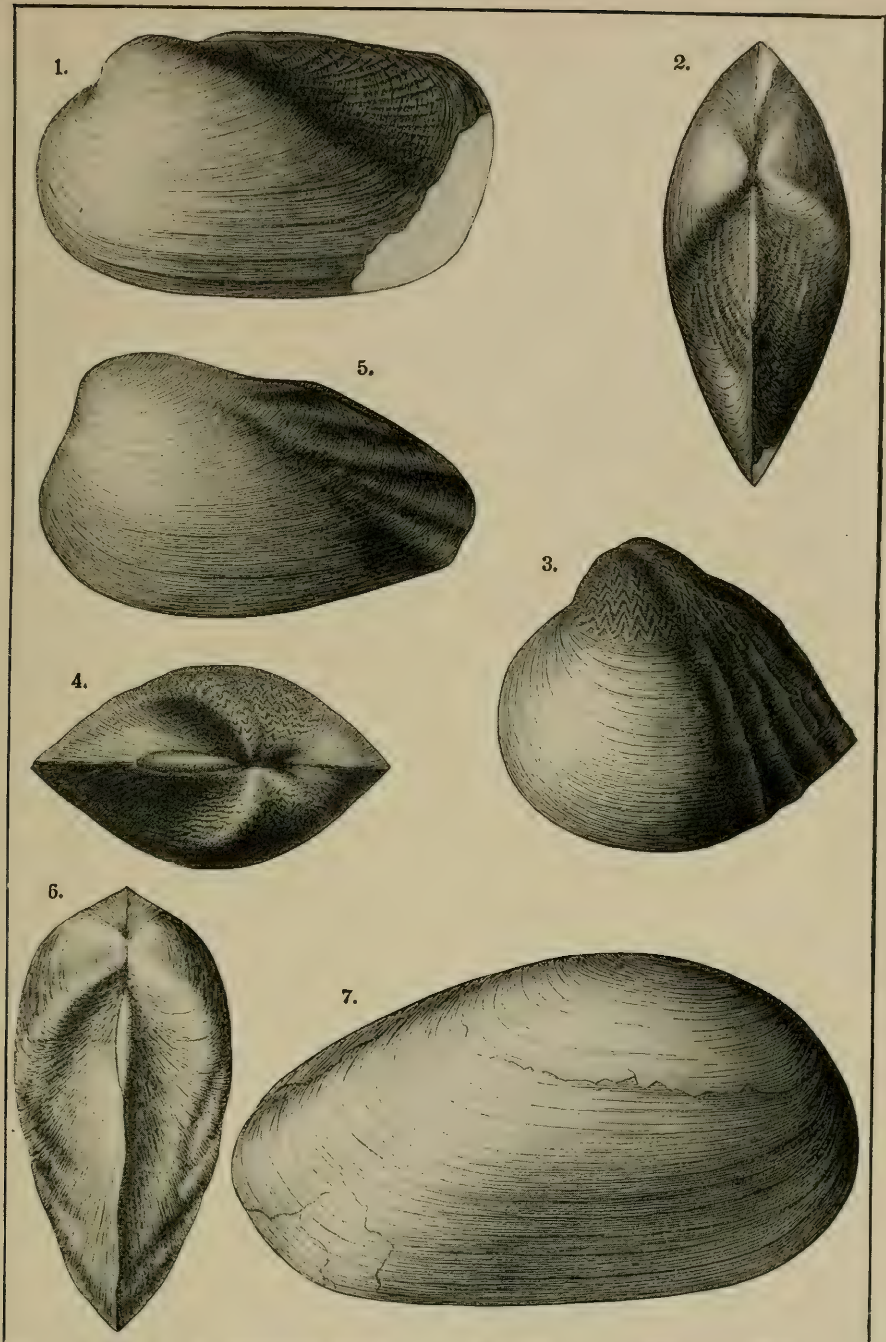
Fig. 5. Left side view; probably a male.

Fig. 6. Dorsal view of the same.

Unio stantoni new species. Laramie Group of the Cretaceous series.

Fig. 7. Right side view.

The specimen here figured under the name of *U. stantoni,* in honor of Dr. T. W. Stanton, was formerly referred to *U. danæ* Meek and Hayden of the Judith River beds; but it proves to be different in specific features and to come from a much higher position in the Cretaceous series.



UNIONIDÆ

BRAIN WEIGHT IN VERTEBRATES

By ALEŠ HRDLIČKA

The following data on brain weight in vertebrates are a contribution to the interesting but not yet ample enough material of similar nature that has been gathered in various parts of the world. Since the writer assumed the charge of the Division of Physical Anthropology in the U. S. National Museum, two years ago, one of the main objects followed was the gradual establishment of a reference brain collection, human and comparative. Due to the generous aid received from the National Zoological Park in Washington City, the division of Mammals and of Birds in the Museum, the Bureau of Animal Industry of the Department of Agriculture, Mr. E. S. Schmidt, the principal animal dealer in the city, and with what was received from various hunters, it has been possible to examine and in most instances preserve the brains of several hundred mammals, birds, and other animals. With these were obtained, wherever feasible, certain records, among which the condition and weight of the body, the sex, the age or stage of life, and the weight of the brain. In addition, Mr. Geo. B. Turner, the Museum taxidermist, furnished a number of measurements of the bodies.

The brains were always weighed without the dura mater and immediately after extraction. No pathological specimens, which fortunately are very rare in animals, were included in the series.

The data have now accumulated so that they may prove of service to others and are therefore here given. They were gathered with due care and so far as they go should prove reliable. The identifications were kindly furnished by Mr. W. L. Hahn and Dr. C. W. Richmond, of the National Museum. A difficulty was found in some cases in concluding as to the stage of life of the animal, but the possible remaining errors on this account can not be numerous. The term "adult" in the records is employed synonymously with "full grown." The considerable source of difficulty and error met with in weighing human brains, namely the various grades of congestion of the organ, is practically absent in the smaller and but rarely encountered among the larger animals. It was present, in a marked degree, in one specimen only (a harbor seal).

The records are arranged in two categories. In the first are in-

cluded all the animals the brains of which were weighed, irrespective of the age of the animal or the condition of its body. In the second class, which is naturally much reduced in number, only those animals are included which were full grown and in which the state of the nutrition of the body was fair; and here the groups have been arranged on the basis of the average brain-body relation only.

The data reveal a number of points which incite comment, but this may better be postponed until the series can be sufficiently increased.

To facilitate reference I append a brief bibliography, limited to the principal contributions to the subject of brain weight in animals; in the works cited are mentioned a number of minor contributions.

The numbers preceding the names of the animals are the catalogue numbers of the brains preserved in the Division of Physical Anthropology in the U. S. National Museum.

I. Arrangement by Species.

MAMMALS.

Cercopithecidæ: *Old World Monkeys.*

No. and Species.	Sex.	Stage of Life.	State of Nutrition.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.	Dimensions of Animal. Length, Point of Nose to Point of Tail.	Length of Tail.	Length of Hind Foot.
224,778 Macacus fascicul.	♂	apparently adult.	medium.	4989.5 gr.	70.6 gr.	1 : 71			
224,770 Macacus fascicul.	♀	" "	"	3855.5	60.3	1 : 64			
224,775 Macacus fascicul.	♂	adult.	"	—	71.—	—			
224,767 Macacus fascicul.	♂	" "	"	—	67.—	—			
224,766 Macacus fascicul.	♂	adult or nearly so.	—	—	63.5	—			
228,085 Macacus fasc'cul.	♂	adult.	slightly emaciated.	4309.	69.75	1 : 62			
224,806 Cercocebus fulig.	♂	adult.	"	3629.—	112.—	1 : 32			
228,117 Cercocebus fulig.	♂	"	"	3855.5	108.—	1 : 36			
224,959 Cercocebus fulig.	♀	"	emaciated.	3175.	105.—	1 : 30			
228,080 Cercopithecus callitr.	♂	"	medium.	3629.—	71.9	1 : 50			
224,830 Cynopithecus niger	♂	"	"	3402.—	110.—	1 : 31			
224,811 Papio doguerra	♂	"	somewhat emaciated.	4989.5	182.—	1 : 27			
228,063 Papio hamadr.	♂	"	"	12020.5	142.—	1 : 85	104 cm.,	44 9 cm.,	17.5 cm.
224,745 Papio cynoceph.	♀	"	"	5443.	162.—	1 : 34			

Cebidæ: *New World Monkeys.*

No. and Species.	Sex.	Stage of Life.	State of Nutrition.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.	Dimensions of Animal. Length, Point of Nose to Point of Tail.	Length of Tail.	Length of Hind Foot.
228,110 Ateles geoffr.	♂	adult.	somewhat emaciated.	1920.—	95.5	1 : 21			
224,799 Ateles geoffr.	♂	"	"	1835.—	91.—	1 : 20			
Cebus hypol.	♂	"	"	1126.—	68.—	1 : 17			
224,812 Cebus hypol.	♂	"	emaciated.	880.—	75.—	1 : 12			
224,829 Cebus hypol.	♂	"	somewhat emaciated.	930.—	66.—	1 : 14			

Hapalidæ: *Marmosets.*

No. and Species.	Sex.	Stage of Life.	State of Nutrition.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.	Dimensions of Animal. Length, Point of Nose to Point of Tail.	Length of Tail.	Length of Hind Foot.
224,969 Marmoset	♂	adult.	medium.	204.—	7.35	1 : 28			
224,970 Marmoset	♂	"	nearly medium.	172.—	7.1	1 : 24			
224,971 Marmoset	♀	"	medium.	219.—	8.8	1 : 24			
224,961 Marmoset	♀	"	"	218.—	7.77	1 : 28			

I. Arrangement by Species.—*Continued.*

MAMMALS.

Lemuridæ: *Lemurs.*

No. and Species.	Sex.	Stage of Life.	Stage of Nutrition.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.	Dimension of Animal. Length, Point of Nose to Point of Tail.	Length of Tail.	Length of Hind Foot.
224,967 Marmoset	♀	adult.	somewhat emaciated.	169.5 gr.	7.85 gr.	1 : 22 gr.			
Midas œdip.	♀	"	"	290.—	8.8	1 : 33			
228,139 Lemur macaco	♂	"	medium.	1899.—	25.5	1 : 75			
228,106 Lemur macaco	♂	"	"	2170.—	21.8	1 : 99.5	97. cm.,	53. cm.,	11. cm.
228,143 Lemur varius	♀	near adult.	"	1250.—	24.—	1 : 52			
224,807 Lemur varius	♀	adult.	—	—	34.5	—			

Phocidæ: *Seals.*

No. and Species.	Sex.	Stage of Life.	Stage of Nutrition.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.	Length, Point of Nose to Point of Tail.	Length of Tail.	Length of Hind Foot.
Phoca vitulina	♂	adult.	medium.	13.154.—	229.5	1 : 57	102. cm.,	10. cm.,	24. cm.
228,076 Phoca vitulina	♂	"	"	12.247.—	214.5	1 : 57			
224.748 Phoca vitulina	♀	"	"	12.701.—	259.—	1 : 49	(Brain congested.)		
228,112 Phoca vitulina	♀	"	"	13.835	225.—	1 : 61			
224,803 Phoca vitulina	?	"	somewhat emaciated.	—	247.—	—			
Phoca vitulina	♀	"	near medium.	11.113	214.5	1 : 51			

Canidæ: *Wolfs, Dogs, Jackals, Foxes.*

No. and Species.	Sex.	Stage of Life.	Stage of Nutrition.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.	
224,744 Canis occidental.	♂	30 days.	medium.	860.—	46.—	1 : 19	same litter.
224,800 Canis occidental.	♀	33 "	above medium.	1848.—	56.53	1 : 32	same litter.
224,801 Canis occidental.	♂	39 "	"	1280.—	59.85	1 : 21	same litter.
224,802 Canis occidental.	♂	40 "	"	1090.—	46.3	1 : 24	same litter.
224,824 Canis nubilis	♂	adult.	"	29.030	115.5	1 : 251	
228,107 Canis dingo	♂	4 days.	"	247.2	9.44	1 : 26	same litter.
228,108 Canis dingo	♀	4 "	"	237.—	9.25	1 : 26	same litter.
Canis dingo	♀	4 "	"	243.—	9.55	1 : 25	same litter.
Canis dingo	♀	4 "	"	247.5	9.05	1 : 27	same litter.
228,119 Canis dingo	♀	20 "	"	748.—	25.07	1 : 30	same litter.
Dog: fox-terrier	♂	young.	"	1417.5	53.—	1 : 27	
224,910 Dog: fox-terrier	♂	"	"	1185.—	53.—	1 : 22	
224,825 Dog: fox-terrier	♀	adult.	"	7938.—	67.—	1 : 118	
228,082 Dog: fox-terrier	♀	"	"	6577.—	65.7	1 : 100	

I. Arrangement by Species.—*Continued.*

MAMMALS.

Canidæ: *Wolfs, Dogs, Jackals, Foxes.*

No. and Species.	Sex.	Stage of Life.	State of Nutrition.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.	Dimensions of Animal. Length, Point of Nose to Point of Tail.	Length of Tail.	Length of Hind Foot.
224,826 Black and tan terrier	♂	adult	medium.	5670.—gr.	70.—gr.	1 : 81			
224,814 Black and tan terrier	♀	"	"	5897.—	61.5	1 : 96			
224,913 Irish terrier	♀	"	"	9526.—	73.—	1 : 130			
224,822 Retriever	♂	"	"	13.154	90.5	1 : 145			
224,950 Cuban Poodle	♂	young.	"	496.—	35.8	1 : 14			
228,118 Canis mesomelas	♂	adult.	"	6124.—	60.6	1 : 101	97. cm.,	27. cm.,	18 cm.
224,796 Vulpes pribilof.	♀	4 hours.	"	397.—	22.4	1 : 18			
228,060 Vulpes pribilof.	?	85 days.	"	760.—	37.5	1 : 20			
224,804 Vulpes pribilof.	♂	adult.	"	—	42.7	—			
224,395 Vulpes pribilof.	♀	"	emaciated.	—	40.—	—			
224,808 Vulpes velox	♂	33 days.	medium.	1910.—	17.—	1 : 112			
224,816 Vulpes velox	♂	adult.	slightly emaciated.	2758.—	33.35	1 : 85			

Felidæ: *Cats and Lynxes.*

No. and Species.	Sex.	Stage of Life.	State of Nutrition.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.	Length, Point of Nose to Point of Tail.	Length of Tail.	Length of Hind Foot.
224,810 Felis concolor	♂	adult.	medium.	54.432	154.—	1 : 353	183.3,	62.2,	30.3.
228,055 Felis concolor	♀	"	"	—	137.5	—			
228,136 Felis jagouar.	♀	"	somewhat emaciated.	2268.—	40.	1 : 57			
228,122 Felis cacomitli	♀	"	"	2722.—	41.9	1 : 65			
228,138 Felis serval	♂	"	medium.	11.340	54.1	1 : 210			
228,089 Felis serval	♀	near adult.	"	7.484	50.5	1 : 148			
228,123 Felis pardalis	♂	adult	"	8618.	62.7	1 : 137			
224,815 Felis pardalis	♂	or near. adult.	"	10.433	63.5	1 : 164			
228,134 Felis onca	♂	"	"	13.835	159.5	1 : 87			
228,131 Felis onca	♂	adolescent.	"	8.436	121.—	1 : 70			
224,380 Felis onca	♂	near adult.	"	—	165.—				
224381 Felis onca	?	"	"	—	160.—				
228,154 Lynx canad.	♂	adult.	"	14.969	69.5	1 : 215			
224,809 Lynx rufus	♂	"	"	6.350	65.—	1 : 98	86.2,	15.1,	17.—

I. Arrangement by Species.—*Continued.*

MAMMALS.

Felidæ: *Cats and Lynxes.*

No. of Species.	Sex.	Stage of Life.	State of Nutrition.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.	Dimensions of Animal. Length, Point of Nose to Point of Tail.	Length of Tail.	Length of Foot.
228,129 Lynx rufus texensis	♀	adult.	emaciated.	1719.5	56.7	1 : 30			
Lynx caracal	♂	2 days.	medium.	175.—	8.6	1 : 20			
224,908 maltese cat (domestic)	♀	young.	"	569.—	23.5	1 : 24			
224,953 maltese cat (domestic)	♂	adult.	emaciated.	1392.—	29.65	1 : 47			
224,948 maltese cat (domestic)	♀	"	medium.	1930.—	21.55	1 : 89			
Ursidæ: *Bears.*									
224,382 Ursus, American.	♂	adult.	medium.	—	230.—	—	149.9 cm.,	12.7 cm.,	—
224,742 U. horribilis	♂	"	"	149.688	389.—	1 : 382	198.12,	—	—
224,386 U. torquatus	♂	adult. (3 years).	"	69.860	269.—	1 : 260			
224,387 U. torquatus	♂	adult (3 years).	somewhat emaciated.	—	282.—	—	132.3,	16.3,	—
228,150 Melursus ursinus	♀	adult.	medium.	136.080	267.—	1 : 510			
224,385 U. japonicus	♂	adolescent	"	—	230.—	—	89.—	5.—	—
224,831 Helarctor malay.	♀	adult.	"	45.020	385.5	1 : 117			
Procyonidæ: *Racoons, etc.*									
224,398 Procyon lotor	♀	young.	medium.	1902.—	39.—	1 : 49	48.7,	23.5,	—
228,125 Procyon lotor	♀	adult.	"	5000.—	36.1	1 : 141			
224,817 Procyon cancriv.	♀	"	"	4819.5	61.5	1 : 78			
228,127 Nasua rufa	♀	"	"	3175.—	34.—	1 : 93			
228,103 Potos caudivolvulus	♂	adult.	medium.	1863.—	35.1	1 : 53	81.—	40.—	11.5
Mustelidæ: *Weasels, Otters, etc.*									
224,798 Mephitis meph.	?	adult or near.	medium.	380.—	6.52	1 : 58			
224,964 Putorius nigripes	♀	adult.	somewhat emaciated.	449.—	7.8	1 : 58			
224,798 Putorius putor.	♂	"	medium.	915.—	7.87	1 : 116			
Erinaceidæ: *Hedgehogs.*									
224,797 Erinaceus europ.	♀	adult.	medium.	453.—	3.23	1 : 140			

I. ARRANGEMENT BY SPECIES.—*Continued.*

MAMMALS.

SORICIDÆ: *Shrews.*

No. and Species.	Sex.	Stage of Life.	State of Nutrition.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.	Dimensions of Animal. Length, Point of Nose to Point of Tail.	Length of Tail.	Length of Hind Foot.
Blarina brevicauda	♀	adult.	medium.	14.—gr.	0.6 gr.	1: 23 gr.			
LEPORIDÆ: *Hares and Rabbits.*									
224,428 Rabbit, dom., ordinary	?	young.	medium.	376.—	6.9	1 : 55			
224,429 Rabbit, dom., ordinary	?	"	"	434.—	6.8	1 : 63			
224,427 Rabbit, dom., ordinary	?	adult.	"	1732.—	11.5	1 : 151			
Rabbit, wild, Md.	?	young.	"	157.—	4.8	1 : 33			
224,974 Rabbit, wild, South Va.	♀	adult.	"	1210.5	9.14	1 : 132			
224,438 Rabbit, wild, South Va.	♂	"	"	1247.5	8.7	1 : 143			
224,436 Belgian hare	♀	near adult.	"	1396.—	8.—	1 : 175			
Belgian hare	♂	" "	"	1545.—	10.67	1 : 145			
" "	♀	" "	"	1771.—	8.8	1 : 201			
224,943 Belgian hare	♀	adult.	"	1890.—	9.38	1 : 201			
Belgian hare	♀	"	"	1975.—	9.8	1 : 202			
" "	♂	"	"	2055.—	9.18	1 : 224			
" "	♀	"	"	2152.—	10.51	1 : 205			
" "	♀	"	"	2431.—	9.9	1 : 246			
" "	♂	"	somewhat emaciated.	2570.—	13.35	1 : 193			
224,434 Belgian hare	♀	"	medium.	2987.—	10.5	1 : 285			
Belgian hare	♀	"	"	3345.—	11.3	1 : 296			
CAVIDÆ: *Cavies.*									
Cavia cutleri	?	?	medium.	91.5	2.95	1 : 31			
" "	"	"	"	131.—	2.95	1 : 44			
" "	"	"	"	138.—	3.25	1 : 42			
" "	"	"	"	200.—	3.42	1 : 58			
" "	"	"	"	211.—	3.85	1 : 55			
" "	"	"	"	238.—	4.15	1 : 57			
" "	"	"	"	248.—	3.77	1 : 66			
" "	"	"	"	265.—	3.8	1 : 70			
" "	"	"	"	295.—	3.65	1 : 81			
" "	"	"	"	301.—	4.7	1 : 64			
" "	"	"	"	305.—	4.15	1 : 73			
" "	"	"	"	337.—	4.28	1 : 79			
" "	"	"	"	353.—	4.5	1 : 73			
" "	"	"	"	451.—	4.8	1 : 94			
" "	"	"	"	491.—	4.75	1 : 103			
" "	"	"	"	513.—	4.57	1 : 112			
224,431 Cavia cutleri	"	"	"	544.—	4.9	1 : 111			
224,935 Cavia cutleri	"	"	"	700.—	4.35	1 : 161			

I. Arrangement by Species.—*Continued.*

MAMMALS.

DASYPROCTIDÆ: *Agoutis.*

No. of Species.	Sex.	Stage of Life.	Stage of Nutrition.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.	Dimensions of Animal. Length, Point of Nose to Point of Tail.	Length of Tail.	Length of Hind Foot.
228,090 Dasyprocta aguti	♂	adult.	medium.	1724.5	19.1	1 : 90			
228,114 Myoprocta acouchy	♀	adult.	medium.	782.—	9.9	1 : 79			
HYSTRICIDÆ: *Porcupines.*									
228,132 Hystrix cristata	♀	adult.	medium.	4763.—	24.2	1 : 197			
MURIDÆ: *Rats, Mice, etc.*									
Mus musculus	♂	adult.	medium.	19.5	0.42	1 : 46			
224,914 Mus musculus	♂	"	"	16.85	0.45	1 : 37			
Mus musculus	♂	"	"	19.5	0.42	1 : 46			
" "	♂	"	"	14.75	0.5	1 : 30			
" "	♀	"	"	18.2	0.48	1 : 38			
" "	♀	"	"	16.5	0.39	1 : 42			
'Japanese mouse'	?	adult.	medium.	7.85	0.35	1 : 22			
" "	?	"	"	7.25	0.33	1 : 22			
White "	♀	"	"	11.35	0.4	1 : 28			
Black and White mouse	?	"	"	8.8	0.23	1 : 38			
Mus rattus	♀	adult.	medium.	99.5	1.27	1 : 78			
224,966 Mus norvegicus	♀	"	"	543.5	2.6	1 : 208			
224,987 Arvicola agrestis	♂	"	"	42.5	0.9	1 : 47			
224,976 Fiber zibethicus	♂	"	"	1260.—	5.59	1 : 225			
GEOMYIDÆ: *Pocket Gophers.*									
224,951 Geomys bursarius	♂	adult.	medium.	108.—	2.83	1 : 38			
HETEROMYIDÆ: *Kangaroo Rats.*									
228,144 Perodipus richards.	♂	adult.	somewhat emaciated.	989.—	11.97	1 : 83			
Perodipus richards.	♂	young.	medium.	289.—	7.3	1 : 40			
OCTODONTIDÆ: *Spiny Mice.*									
228,135 Capromys pilor.	♂	adult.	medium.	4989.5	11.9	1 : 450			
222,600 Capromys pilor.	♂	"	somewhat emaciated.	2782.5	11.1	1 : 251			
228,133 Capromys pilor.	♀	"	medium.	3429.—	10.55	1 : 344			

I. Arrangement by Species.—*Continued.*

MAMMALS.

Sciuridæ: *Squirrels and Marmots.*

No. and Species.	Sex.	Stage of Life.	State of Nutrition.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.	Dimensions of Animal. Length, Point of Nose to Point of Tail.	Length to Tail.	Length of Hind Foot.
224,917 Sciurus rufiventer	♀	adolescent	medium.	401.—	8.85	1 : 45			
Sciurus rufiventer	♀	"	"	403.—	7.7	1 : 52			
" "	♀	adult.	"	522.5	8.95	1 : 58			
" "	♂	"	"	559.—	9.15	1 : 61			
224,915 Sciurus rufiventer	♂	"	"	578.—	9.05	1 : 64			
Sciurus rufiventer	♀	"	"	584.—	8.4	1 : 70			
" "	♀	"	"	650.—	9.2	1 : 71			
Sciurus carolin.	♀	adolescent	"	300.—	6.44	1 : 47			
224,437 Sciurus carolin.	♀	"	"	312.—	6.7	1 : 47			
Sciurus carolin.	♀	"	"	321.—	6.83	1 : 47			
" "	♀	adult or near.	"	364.—	7.02	1 : 52			
" "	♀	adult.	"	399.—	7.5	1 : 53			
" "	♂	"	"	401.—	7.7	1 : 52			
" "	♀	"	"	404.5	7.6	1 : 53			
" "	♀	"	"	410.—	6.55	1 : 63			
" "	♂	"	"	438.—	7.2	1 : 61			
" "	♀	"	"	445.—	7.84	1 : 57			
" "	♂	"	"	459.5	7.15	1 : 64			
" "	♀	"	"	468.—	7.03	1 : 67			
" "	♀	"	"	470.—	8.22	1 : 57			
" "	♂	"	"	502.—	7.67	1 : 65			
" "	♀	"	"	502.—	7.7	1 : 65			
" "	♀	"	"	510.—	6.8	1 : 75			
" "	♂	"	"	514.—	7.58	1 : 68			
" "	♀	"	"	522.5	8.95	1 : 58.4			
" "	♂	"	"	595.5	8.25	1 : 72			
224,901 Sciurus hudson.	♂	adolescent	"	100.—	4.09	1 : 24.5			
Sciurus hudson.	♀	8 months.	"	102.5	3.82	1 : 27			
" "	♂	"	"	140.—	4.05	1 : 35			
" "	♀	adolescent	"	123.—	3.94	1 : 31			
" "	♀	adult, or near.	"	139.—	3.97	1 : 35			
" "	♀	adult.	"	145.—	3.87	1 : 37			
" "	♀	"	"	147.—	4.—	1 : 37			
224,446 Sciurus hudson.	♂	"	"	152.5	4.43	1 : 34			
224,936 Sciurus hudson.	♀	"	"	158.—	4.1	1 : 39			
224,448 Sciurus hudson.	♂	"	"	173.5	4.02	1 : 43			
Sciurus hudson.	♀	"	"	179.—	4.2	1 : 42.6			
Sciuropterus volans	♂	young.	"	32.—	2.6	1 : 12			
Sciuropterus volans	♀	adolescent	"	51.—	1.65	1 : 31			
Sciuropterus volans	♀	adult.	"	55.—	1.84	1 : 30			
224,447 Sciuropterus volans	♂	"	"	58.3	1.92	1 : 30			

I. Arrangement by Species.—*Continued.*

MAMMALS.

Sciuridæ: *Squirrels and Marmots.*

No. of Species.	Sex.	Stage of Life.	State of Nutrition.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.	Dimensions of Animal. Length, Point of Nose to Point of Tail.	Length of Tail.	Length of Hind Foot.
224,715 Sciuropterus volans	♂	adult.	medium.	59.—	2.—	1 : 29.5			
Sciuropterus volans	♀	"	"	60.5	2.1	1 : 29			
Sciuropterus volans	♂	"	"	61.5	1.96	1 : 31			
Sciuropterus volans	♂	"	"	64.—	1.92	1 : 33			
224,977 Sciuropterus volans	♂	"	quite fat.	78.7	1.8	1 : 44			

Bovidæ: *Sheep, Cattle, etc.*

No. of Species.	Sex.	Stage of Life.	State of Nutrition.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.	Length, Point of Nose to Point of Tail.	Length of Tail.	Length of Hind Foot.
224,932 Sheep, Merino	♂	adult, or near.	medium.	23.134	91.—	1 : 254			
224,998 Sheep, Shropshire	♀	9 months.	"	32.206	112.8	1 : 285			
224,927 Sheep, Shropshire	♀	adult, or near.	"	34.474	98.—	1 : 352			
228,075 Ovis tragel.	♂	1 year.	medium.	47.174 gr.	215.—	1 : 219			
228,151 Ovis tragel.	♀	adult.	"	56.700	209.5	1 : 271			
228,073 Ovis canaden.	♀	adolescent.	somewhat emaciated.	26.536	198.—	1 : 134			
228,065 Antelope cervicapra	♂	young.	medium.	10.093	98.5	1 : 102			
228,068 Antelope cervicapra	♂	adult.	"	—	114.5	—			
228,155 Boselaphus tragocam.	♂	"	—	—	258.—	—			
224,820 Bison bison	♂	4 years.	medium.	—	529.—	—	213 cm.	—	—

Antilocapridæ: *Prong Bucks.*

No. of Species.	Sex.	Stage of Life.	State of Nutrition.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.	Length, Point of Nose to Point of Tail.	Length of Tail.	Length of Hind Foot.
228,111 Antilocapra amer.	♂	adult.	medium.	34.474	130.2	1 : 265			

Cervidæ: *Deer, etc.*

No. of Species.	Sex.	Stage of Life.	State of Nutrition.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.	Length, Point of Nose to Point of Tail.	Length of Tail.	Length of Hind Foot.
224,743 Alces amer.	♂	adult.	medium.	272.160	407.—	1 : 669	244.	—	—
228.092 Alces amer.	♂	adult or near.	"	—	337.2	—	226.	—	—
224,819 Alces amer.	♀	adult.	"	—	406.—	—	236.2	—	—
224,805 Cervus canadens.	♂	new born.	"	14.969	209.—	1 : 71			
228,059 Cervus canadens.	?	young.	—	—	374.8	—			
228,074 Cervus canadens.	♂	7 years.	—	—	461.1	—			

I. Arrangement by Species.—*Continued.*

MAMMALS.

Cervidæ : *Deer, etc.*

No. and Species.	Sex.	Stage of Life.	State of Nutrition.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.	Dimensions of Animal. Length, Point of Nose to Point of Tail.	Length of Tail.	Length of Hind Foot.
228,086 Odocoileus virgin.	♀	young.	medium.	14.515	133.—	1 : 109			
228,087 Odocoileus virgin.	♀	adult.	somewhat emaciated.	33.566	174.7	1 : 192			
224,828 Odocoileus virgin.	♀	"	medium.	—	175.5	—			
224,821 Odocoileus virgin.	♀	"	"	—	203.—	—			
224,823 Odocoileus virgin.	♂	"	"	—	219.5	—			
224,391 Odocoileus hemion.	♂	young.	"	9412.—	116.5	1 : 81			
228,054 Odocoileus hemion.	♀	"	"	—	78.—	—			
228,078 Odocoileus hemion.	♀	adult.	"	—	128.2	—	101.—cm.,	12.cm.,	36.—cm.
228,072 Odocoileus hemion.	♀	"	emaciated.	10.319	112.—	1 : 92	96.cm.,	11.5cm.,	—cm.
228,066 Capreolus caprea	♀	young.	somewhat emaciated.	8165.—	85.—	1 : 96			
228,084 Capreolus caprea	♀	adolescent.	medium.	13.154	90.—	1 : 146			
228,113 Capreolus caprea	♀	adult, or near.	"	12.706	94.5	1 : 134			
Capreolus caprea	♂	adult.	"	14.062	93.—	1 : 151			
228,088 Capreolus caprea	♀	adult.	medium.	15.422	103.5	1 : 149	105 cm.,	—,	35 cm.
228,140 Odocoileus truei.	♂	"	"	34.927	127.4	1 : 274			
224,389 Odocoileus truei.	♂	"	"	39.010	129.—	1 : 302			
228,147 Odocoileus columb.	♀	"	somewhat emaciated.	33.113	188.3	1 : 176			
228,079 Cervus dama.	♀	"	medium.	37.195	224.5	1 : 166			

Dicotilidæ : *Peccaries.*

228,070 Tayassu tajac.	♀	adult.	medium.	19.618	101.—	1 : 194			

Suidæ : *Pigs.*

224,904 Sus famil.	?	adolescent	quite fat.	90.720	130.—	1 : 697			
224,907 Sus scrofa	♂	adult.	medium.	—	186.—	—			

Dasypobidæ : *Armadillos.*

224,393 Tatu novemcinctum	♂	adult.	medium.	4593.—	14.—	1 : 328			

I. Arrangement by Species.—*Continued.*

MAMMALS.

Bradipodidæ: *Sloths.*

No. of Species.	Sex.	Stage of Life.	State of Nutrition.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.	Dimensions of Animal. Length, Point of Nose to Point of Tail.	Length of Tail.	Length of Hind. Foot.
222,598 Cyclopes didactyl.	?	adolescent	medium.	907.—	24.2	1 : 37			

Macropodidæ: *Kangaroos.*

No. of Species.	Sex.	Stage of Life.	State of Nutrition.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.	Length, Point of Nose to Point of Tail.	Length of Tail.	Length of Hind. Foot.
224,392 Onychogale frenata	♂	adolescent	medium.	2722.—	12.7	1 : 214			
224,397 Onychogale frenata	♂	adult, or near.	"	—	14.—	—			
228,142 Onychogale frenata	♂	adult.	"	5216.—	16.2	1 : 322			
228,061 Macropus ceim.	♀	adult, or near.	"	—	29.1	—			
224,388 Macropus, spec. ?	♀	adult.	"	10.206	37.—	1 : 276			
228,148 Petrogale	♂	"	"	11.794	34.5	1 : 342			
228,149 Petrogale	♂	"	"	11.795	39.8	1 : 296			

Phalangeridæ: *Phalangers.*

No. of Species.	Sex.	Stage of Life.	State of Nutrition.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.	Length, Point of Nose to Point of Tail.	Length of Tail.	Length of Hind. Foot.
228,069 Trichosurus vulpec.	?	adolescent.	medium.	825.— gr.	8.97 gr.	1 : 92			
228,128 Trichosurus vulpec.	♀	adult, or near.	"	1371.5	9.7	1 : 141			
228,141 Trichosurus vulpec.	♂	adult.	"	1898.—	11.—	1 : 172.5			
222,599 Trichosurus fulig.	♂	adult, or near.	"	3175.—	12.9	1 : 246			
228,115 Trichosurus fulig.	♀	adult.	"	4196.—	12.27	1 : 342	86.—cm.,	33.5cm.,	8. cm.—

Dasyuridæ: *Dasyures, etc.*

No. of Species.	Sex.	Stage of Life.	State of Nutrition.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.	Length, Point of Nose to Point of Tail.	Length of Tail.	Length of Hind. Foot.
224,818 Dasyurus macul.	♂	adult.	medium.	355.—	4.07	1 : 87			
228,120 Dasyurus macul.	♀	"	"	420.—	5.35	1 : 79	49.2,	21.2,	6.4
228,124 Thylacinus cynocept.	♂	"	"	14.969	43.—	1 : 348			

Lizards.

No. of Species.	Sex.	Stage of Life.	State of Nutrition.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.
224,426 Alligator mississip.	?	about half grown.	medium.	11.340	5.—	1 : 2835
224,952 Alligator mississip.	?	very young.	"	39.5	0.83	1 : 48
Alligator mississip.	?	very young.	"	32.—	0.56	1 : 57
Anolis principal.	?	?	"	106.—	1.15	1 : 92

Snakes.

No. of Species.	Sex.	Stage of Life.	State of Nutrition.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.
Pine snake	?	150.6 cm. long.	medium.	766.—	0.45	1 : 1702
" "	?	181.2 cm. long.	sub-medium.	610.—	0.7	1 : 871
Cuban tree boa	?	?	medium.	877.—	0.48	1 : 1828

I. Arrangement by Species.

BIRDS.

Passeriformes : *Corvidæ.*

Object.	Sex.	Stage of Life.	State of Body.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.
224,444 Corvus brachyrhynchus	?	adult.	medium.	302.0 gr.	7.3 gr.	1 : 41
Corvus brachyrhynchus	?	"	"	341.0	7.75	1 : 44
224,930 Corvus brachyrhynchus	?	"	"	352.0	7.55	1 : 47
Corvus brachyrhynchus	?	"	"	359.0	9.3	1 : 39
224,443 Corvus brachyrhynchus	?	"	" "	440.0	8.9	1 : 49
224,986 Corvus brachyrhynchus	?	"	medium.	459.2	8.55	1 : 54
224,956 Corvus brachyrhynchus (Domesticated)	?	"	above medium.	1134.0	8.75	1 : 130
224,941 Corvus brachyrhynchus (Domesticated)	?	"	above medium.	1134.0	8.75	1 : 130
224,445 Corvus monedula	?	"	medium.	147.0	5.35	1 : 27
224,996 Cyanocitta cristata	?	"	somewhat	88.0	2.98	1 : 30
224,956 " "	?	"	emaciated.	67.4	3.02	1 : 22
228,105 Xanthura luxuosa	?	"	somewhat emaciated.	44.5	2.4	1 : 19
228,052 " "	?	"	medium.	60.0	2.4	1 : 25

Fringillidæ.

Object.	Sex.	Stage of Life.	State of Body.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.
224,954 Acanthis cannabina	?	adult.	medium.	16.8 gr.	0.69 gr.	1 : 24
Passer domesticus	♂	"	"	23.1	1.05	1 : 22
Melospiza cinerea melodia	♂	"	"	21.5	0.88	1 : 24
Carpodacus purpureus	♀	"	"	19.7	0.85	1 : 23
Gold Finch	?	?	somewhat emaciated.	9.08	0.6	1 : 15
" "	?	?	somewhat emaciated.	10.9	0.58	1 : 19
" "	?	adult.	somewhat emaciated.	13.2	0.6	1 : 21
" "	?	?	somewhat emaciated.	13.3	0.55	1 : 24
" "	?	?	somewhat emaciated.	14.45	0.7	1 : 21
Bull "	?	?	somewhat emaciated.	25.1	0.96	1 : 26
Serinus	?	?	somewhat emaciated.	11.23	0.53	1 : 20
"	?	?	somewhat emaciated.	11.35	0.53	1 : 21
"	?	?	somewhat emaciated.	11.5	0.60	1 : 19
"	?	?	somewhat emaciated.	11.86	0.66	1 : 18
"	?	?	medium.	12.55	0.53	1 : 24
"	?	?	"	13.4	0.58	1 : 23
"	?	?	"	13.5	0.59	1 : 23
"	?	?	"	14.02	0.52	1 : 27
"	?	adult.	"	14.2	0.65	1 : 22

I. Arrangement by Species.—*Continued.*

BIRDS.

Fringillidæ.

Object.	Sex.	Stage of Life.	State of Body.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.
224,903 Serinus	?	?	medium.	14.2 gr.	0.57 gr.	1 : 25
Serinus	?	?	"	14.49	0.59	1 : 25
224,931 Serinus	?	adult.	"	14.6	0.56	1 : 26
Serinus	?	"	"	16.0	0.66	1 : 24
"	♂	"	"	16.3	0.71	1 : 23
"	?	"	"	16.45	0.6	1 : 27
"	?	?	"	—	0.75	—
"	♂	adult.	"	17.9	0.72	1 : 25
"	♂	young.	"	11.2	0.7	1 : 16
Cardinalis cardinalis	♀	adult.	"	43.5	1.45	1 : 30
228,098 Paroaria larvata	?	"	"	24.5	1.09	1 : 23
Paroaria larvata	?	"	"	26.6	1.25	1 : 21
228,097 Paroaria larvata	?	"	"	28.0	1.15	1 : 24
228,099 Paroaria cucullata	?	"	"	29.0	1.15	1 : 25
Paroaria cucullata	?	"	"	31.0	1.15	1 : 27
" "	?	"	"	31.2	1.07	1 : 29
" "	?	"	"	32.5	1.30	1 : 25
" "	?	"	"	33.9	1.27	1 : 27
" "	?	"	"	35.2	1.32	1 : 27
" "	?	"	"	35.5	1.32	1 : 26
" "	?	"	"	38.0	1.18	1 : 32
Paroaria	?	?	"	26.6	1.12	1 : 24
224,934 Paroaria	♀	adult.	"	30.2	1.18	1 : 26
224,450 Zonotrichia albicollis	♂	"	"	31.6	1.07	1 : 30
Junco hyenalis	?	"	"	17.7	0.86	1 : 21

Ploceidæ.

Object.	Sex.	Stage of Life.	State of Body.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.
Sporaeginthus amandava	♂	adult.	medium.	5.2 gr.	0.39 gr.	1 : 13
" "	♀	"	"	6.2	0.42	1 : 15
" "	♂	"	"	6.7	0.45	1 : 15
224,975 Munia	?	"	somewhat emaciated.	9.5	0.52	1 : 18
Munia	?	"	"	20.15	0.71	1 : 28
"	♂	"	"	30.0	0.88	1 : 34
Munia oryzivora	?	"	"	19.6	0.9	1 : 22
" "	?	"	"	21.0	0.85	1 : 25
224,746 Munia oryzivora	?	"	"	21.0	0.75	1 : 28
224,940 Munia oryzivora	?	"	"	23.0	0.8	1 : 29
Munia oryzivora	?	"	medium.	20.5	0.7	1 : 29
Munia malacca	♂	"	"	10.8	0 56	1 : 19

Laniidæ.

Object.	Sex.	Stage of Life.	State of Body.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.
228,083 Lanius collurio	?	adult.	somewhat emaciated.	64.0 gr.	2.38 gr.	1 : 27

Alaudidæ.

Object.	Sex.	Stage of Life.	State of Body.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.
224,906 Alauda arvensis	?	adult.	medium.	21.9 gr.	0.7 gr.	1 : 31

Octeridæ.

Object.	Sex.	Stage of Life.	State of Body.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.
Sturnella magna	?	adult.	medium.	135.0 gr.	2.3 gr.	1 : 59
Agelaius phœniceus	?	"	"	66.0	1.77	1 : 37

I. Arrangement by Species.—*Continued.*

BIRDS.

Sylvidæ.

Object.	Sex.	Stage of Life.	State of Body.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.
224,989 Sylvia atricapila	?	adult.	medium.	12.9 gr.	0.75 gr.	1 : 17
Turdidæ.						
224,973 Merula merula	♂	adult.	medium.	88.0 gr.	1.6 gr.	1 : 55
224,933 Kittacincla macroura	?	?	somewhat emaciated.	19.6	0.9	1 : 22
Aedon luscinia	?	?	slightly emaciated.	13.55	0.64	1 : 21
Erithacus rubecula	?	adult.	medium.	10.3	0.65	1 : 16
224,983 Erithacus rubecula	?	"	"	11.0	0.75	1 : 15
Robin (American)	♀	"	"	91.5	1.72	1 : 53
Mimidæ.						
Mimus polyglottus	♂	adult.	somewhat emaciated.	29.5 gr.	1.6 gr.	1 : 18
"	♂	?	"	29.5	1.5	1 : 20
222,442 Mimus polyglottus	♂	adult.	medium.	33.5	1.35	1 : 25
224,990 "	?	"	"	48.5	1.31	1 : 37
Mimus polyglottus	?	"	"	55.0	1.55	1 : 35
Crateropodidæ.						
224,992 Leiothrix lutea	?	adult.	medium.	16.4 gr.	1.07 gr.	1 : 15
Paridæ.						
Parus	♂	?	medium.	9.0 gr.	0.48 gr.	1 : 19
Coraciiformes : *Alcedinidæ.*						
228,056 Dacelo gigas	?	adult.	medium.	210.0 gr.	4.47 gr.	1 : 47
Columbiformes : *Columbidæ.*						
224,985 Columbig allina	♀	adult.	medium.	30.5 gr.	0.6 gr.	1 : 51
Columbig allina	?	"	"	45.5	0.94	1 : 48
224,923 Turtur risorius	♀	"	"	109.0	1.05	1 : 104
Turtledove	?	"	"	72.0	1.08	1 : 67
"	?	"	"	91.5	1.35	1 : 68
224,968 Ocyphaps lophotes	♂	"	"	148.0	1.72	1 : 86
224,962 " "	?	"	somewhat emaciated.	118.5	1.67	1 : 71
Pigeon (domestic)	?	"	medium.	188.5	1.9	1 : 99
224,978 Pigeon (domestic)	♂	"	"	232.5	1.97	1 : 118
Pigeon (domestic)	?	"	somewhat emaciated.	154.0	2.02	1 : 76
224,911 Pigeon (Pigmy Ponter)	♀	"	medium.	221.0	1.35	1 : 163
Pigeon (Pigmy Ponter)	?	"	"	227.0	1.87	1 : 121
224,918 Pigeon (Pigmy Ponter)	?	"	"	232.5	2.0	1 : 116
224,945 Pigeon (Ice Pigeon)	♂	"	"	184.0	2.12	1 : 87

I. Arrangement by Species.—*Continued.*

BIRDS.

Columbiformes : *Columbidæ.*

Object.	Sex.	Stage of Life.	State of Body.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.
Pigeon (Ice Pigeon)	?	adult.	medium.	186.0	2.1	1 : 89
224,905 Pigeon (Homer)	♂	"	"	260.0	2.25	1 : 116

Psittaci : *Psittacidæ.*

Object.	Sex.	Stage of Life.	State of Body.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.
Amazona panamensis	?	adult.	medium.	266.0 gr.	7.55 gr.	1 : 35
" "	?	"	somewhat emaciated.	279.0	9.26	1 : 30
" "	?	"	medium.	300.2	8.65	1 : 35
224,928 Amazona panamensis	?	"	"	330.0	8.45	1 : 39
Amazona panamensis	?	"	"	339.0	9.45	1 : 36
224,441 Amazona panamensis	♂	"	"	368.0	8.35	1 : 44
224,958 Amazona panamensis	?	"	somewhat emaciated.	281.5	9.46	1 : 30
224,960 Amazona panamensis	?	"	somewhat emaciated.	282.2	8.9	1 : 32
Amazona panamensis	?	"	somewhat emaciated.	292.0	9.85	1 : 30
224,980 Amazona panamensis	?	"	somewhat emaciated.	302.5	10.35	1 : 29
Amazona panamensis	?	"	quite emaciated.	270.0	9.8	1 : 28
" oratrix	?	young.	somewhat emaciated.	49.0	2.4	1 : 20
224,955 Amazona	?	adult.	slightly emaciated.	210.0	6.85	1 : 31
224,920 Amazona leucocephala	♂	"	medium.	204.0	6.62	1 : 31
224,921 Amaozna leucocephala	♂	"	"	236.5	5.8	1 : 41
224,963 Amazona leucocephala	?	"	"	247.0	5.8	1 : 43
Amazona leucocephala	?	"	"	253.0	6.8	1 : 37
224,919 Amazona leucocephala	♀	"	medium.	268.0	6.9	1 : 39
Amazona leucocephala	?	"	slightly emaciated.	162.5	6.0	1 : 27
224,926 Amazona leucocephala	?	?	slightly emaciated.	197.0	7.2	1 : 27
224,972 Amazona leucocephala	?	adult.	slightly emaciated.	269.0	8.3	1 : 32
224,947 Psittacus erithacus	♀	"	somewhat emaciated.	254.0	8.7	1 : 29
224,929 " "	♂	"	medium.	327.0	8.67	1 : 38
224,902 " "	?	"	"	342.0	9.75	1 : 35
224,922 Melopsittacus undulatus	?	"	"	20.7	1.2	1 : 17
224,997 Melopsittacus undulatus	?	"	"	28.0	1.4	1 : 20
Melopsittacus undulatus	?	"	slightly emaciated.	16.0	1.02	1 : 16
Paroquet ?	♀	"	medium.	188.0	6.0	1 : 31

I. Arrangement by Species.—*Continued.*

BIRDS.

Psittaci : *Psittacidæ.*

Object.	Sex.	Stage of Life.	State of Body.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.
224,439 Callopsittacus novæ hollandiæ	♂	adult.	medium.	78.0 gr.	2.75 gr.	1 : 28
Brotogerys jugularis	?	"	"	37.0	1.92	1 . 29
Cacatuidæ.						
Cacatua moluccensis	?	?	medium.	335.0 gr.	7.0 gr.	1 : 48
Raptores : *Falconidæ.*						
224,957 Aquila chrysætos	?	adult.	medium.	—	17.1 gr.	—
224,747 " "	?	"	"	5273.1 gr.	18.6	1 : 292
224,995 Buteo lineatus	?	young.	"	337.0	7.4	1 : 46
Buteo lineatus	?	adult.	"	642.0	7.12	1 : 90
224,912 Falco sparverius	?	?	"	75.0	2.75	1 : 27
228,126 Maricoba Hawk	?	adult.	somewhat emaciated.	330.0	6.05	1 : 55
Cathartidæ.						
224,449 Cathartes aura	♀	adult.	medium.	2381.4 gr.	11.6 gr.	1 : 205
224,937 " "	?	"	"	—	10.2	—
Cathartes aura	?	"	somewhat emaciated.	2065.0	10.8	1 : 191
" "	?	"	somewhat emaciated.	1530.0	9.85	1 : 155
Burbonidæ.						
224,982 Megascops asio	♂	adult.	medium.	129.8	5.6	1 : 23
228,081 Strix pratincola	?	"	"	405.0	6.7	1 : 60
224,991 " "	?	"	"	419.0	8.0	1 : 52
224,981 Sirnium varium	?	"	"	572.5	12.5	1 : 46
224,946 " "	♂	"	"	676.0	12.1	1 : 56
Nyctea nyctea	?	"	"	1049.0	15.4	1 : 68
224,827 Bubo virginianus	?	"	"	952.0	13.65	1 : 70
228,116 " "	?	"	"	1232.5	14.42	1 : 85
Steganopodes : *Anhingidæ.*						
228,053 Anhinga anhinga	♂	adult.	medium.	560.0 gr.	4.23 gr.	1 : 132
228,051 " "	♀	"	"	610.0	4.55	1 : 134
228,057 " "	♂	"	"	1040.0	4.45	1 : 234
Herodiones : *Ardeidæ.*						
228,071 Florida cærulea	?	adult.	medium.	178.5 gr.	3.7 gr.	1 : 48
228,091 " "	?	"	"	401.0	3.78	1 : 106
Ardea herodias	♂	?	"	1900.0	8.85	1 : 216
228,062 Ardea herodias	?	?	"	2055.0	10.2	1 : 201
228,137 Ardea tricolor ruficollis	?	adult.	"	324.5	3.45	1 : 94
228,153 Botaurus lentiginosus	?	"	"	378.0	5.15	1 : 73
228,121 Botaurus lentiginosus	?	"	"	429.5	4.4	1 : 98
228,813 Nycticorax nævius	?	"	"	420.0	7.0	1 : 60

I. Arrangement by Species.—*Continued.*

BIRDS.

Ciconiidæ.

Object.	Sex.	Stage of Life.	State of Body.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.
Stork	?	adult.	medium.	—	29.5 gr.	—
228,145 Tantaulus loculator	?	"	"	1955.3 gr.	14.85	1 : 138
224,832 " "	?	"	emaciated.	—	11.87	—

Ibididæ.

Object.	Sex.	Stage of Life.	State of Body.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.
228,093 Plegadis guarama	♀	adult.	medium.	301.0 gr.	4.6 gr.	1 : 65

Alectorides : *Rallidæ.*

Object.	Sex.	Stage of Life.	State of Body.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.
228,102 Rail	?	adult.	medium.	34.5 gr.	1.4 gr.	1 : 25
224,435 Fulica americana	?	not fully adult.	"	383.0	2.7	1 : 142
Golden Seabright Chicken	♀	?	"	302.0	2.56	1 : 118
224,942 Golden Seabright Rooster	♂	adult.	"	713.0	2.43	1 : 293
Chicken	♀	"	"	975.0	3.0	1 : 325
Rooster	♂	?	"	1508.0	3.45	1 : 437
Chicken	♀	adult.	"	2303.0	3.78	1 : 609
224,938 "Brähmer" Chicken	♀	"	above medium.	3128.0	4.22	1 : 741

Galliformes : *Phasianidæ.*

Object.	Sex.	Stage of Life.	State of Body.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.
224,432 Numida cristata	?	?	medium.	467.0 gr.	3.0 gr.	1 : 155
224,924 Pavo cristatus	♀	adult.	"	3060.0	6.7	1 : 457

Tetraonidæ.

Object.	Sex.	Stage of Life.	State of Body.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.
224,979 Lophortyx californicus	?	adult.	medium.	151.8 gr.	1.22 gr.	1 : 124
Lophortyx californicus	?	"	somewhat emaciated.	102.0	1.5	1 : 68
Calipepla squamata	?	"	somewhat emaciated.	99.0	1.5	1 : 66
Colinus virginianus	♀	"	slightly emaciated.	94.0	1.23	1 : 76
" "	♂	"	medium.	95.0	1.23	1 : 77
" "	?	"	"	96.0	1.15	1 : 84
" "	♀	"	"	99.0	1.22	1 : 81
" "	♀	"	"	103.0	1.12	1 : 116
" "	♂	"	"	105.0	1.31	1 : 80
" "	♀	"	"	108.0	1.37	1 : 79
" "	♂	"	"	111.5	1.22	1 : 91
" "	♂	"	"	112.0	1.18	1 : 95
" "	♀	"	"	114.0	1.23	1 : 93
" "	♀	"	"	122.0	1.16	1 : 105
" "	♀	"	"	129.0	1.22	1 : 106
" "	♀	"	"	132.0	1.2	1 : 110
" "	?	?	"	137.0 gr.	1.25 gr.	1 : 110
" "	♂	adult.	"	139.0	1.24	1 : 112
" "	♂	"	"	146.0	1.22	1 : 120
" "	♀	"	"	147.0	1.31	1 : 112
224,909 Colinus virginianus	♀	"	"	153.0	1.35	1 : 113
Colinus virginianus	♂	"	"	160.0	1.16	1 : 138
224,433 Colinus virginianus	?	"	"	198.45	1.2	1 : 165
224,994 Borasa umbellus	♀	"	"	299.3	2.7	1 : 111

I. Arrangement by Species.—*Continued.*

BIRDS.

Limicoliformes : *Charadriidæ.*

Object.	Sex.	Stage of Life.	State of Body.	Weight of Body.	Weight of Brain.	Proportion of Brain to Body.
Oxyechus vociferus	?	adult.	medium.	88.0 gr.	1.22 gr.	1 : 72
Laridæ.						
228,096 Larus argentatus.	?	adult.	medium.	748.0 gr.	7.35 gr.	1 : 102
224,984 " "	?	"	"	1145.0	7.02	1 : 163
Lamellirostres : *Phœnicopteridæ.*						
228,064 Phœnicopterius ruber	?	adult.	medium.	—	10.26gr.	—
228,067 Phœnicopterius ruber.	?	"	"	1579.5 gr.	10.55	1 : 150
Phœnicopterius ruber	?	"	"	1638.0	10.8	1 : 152
228,058 Phœnicopterius ruber	?	"	"	1720.0	11.65	1 : 147
Anatidæ.						
228,146 Cygnus gilbus	?	adult.	medium.	4989.6 gr.	16.4 gr.	1 : 304
Cygnus gilbus	?	"	somewhat emaciated.	4082.4	14.4	1 : 284
228,101 Cygnus olor	?	"	medium.	5528.25	14.5	1 : 381
224,925 Aix galericulata	?	?	"	299.0	4.22	1 : 71
225,00 Anas ?	?	adult.	"	—	4.09	—
224,999 Anas ?	?	"	"	—	4.19	—
228,130 Anas obscura	?	"	"	853.0	7.25	1 : 118
228,152 Nettion carolinensis	?	"	"	155.5	3.45	1 : 45
228,095 " "	?	"	"	187.5	3.15	1 : 60
228,094 " "	?	"	"	196.0	2.95	1 : 66
Nettion carolinensis	♀	"	"	252.6	3.25	1 : 78
" "	♂	"	"	271.7	3.05	1 : 89
224,949 'White Pekin' Duck	?	"	"	—	6.18	—
Crypturi : *Casuariidæ.*						
228,104 Casaurius galeatus	?	adult.	medium.	—	31.7 gr.	—
Dromæidæ.						
282,077 Dromaius novæ hollandiæ	♀	adult.	medium.	—	20.3 gr.	—

II. Arrangement by Average of Relative Brain Weight.

MAMMALS.

Species.	Proportion of Brain to Body. Aver. 1 to ...	Indvs. 1 to ...
Fancy mice,	22	a 22
		b 22
Blarina brevicauda,	23	a 23
Marmosets,	26	a 24
		b 24
		c 26
		d 26
White mouse,	28	a 28
Cynopithecus niger,	31	a 31
Sciuropterus volans,	32	a 29
		b 29.5
		c 30
		d 30
		e 31
		f 33
		g 44
Geomys bursarius,	38	a 38
Black and white fancy mouse	38	a 38
Sciurus hudsonicus,	39	a 34
		b 37
		c 37
		d 39
		e 42.5
		f 43
Mus musculus,	40	a 30
		b 37
		c 38
		d 42
		e 46
		f 46
Arvicola agrestis,	47	a 47
Cercopithecus callitr.,	50	a 50
Potos caudivolvulus,	53	a 53
Phoca vitulina,	55	a 49
		b 51
		c 57
		d 57
		e 61
Mephitis mephitica,	58	a 58
Sciurus carolin,	62	a 52
		b 53
		c 53
		d 57
		e 57
		f 58
		g 61
		h 63
		i 64
		j 65
		k 65
		l 67
		m 68
		n 72
		o 75
Sciurus rufiventer,	65	a 58
		b 61
		c 64
Sciurus rufiventer		d 70
		e 71
Macacus fascicul,	67	a 64
		b 71
Mus rattus,	78	a 78
Procyon cancriv,	78	a 78
Myoprocta acouchy,	79	a 79
Dasyurus macul,	83	a 79
		b 87
Lemur macaco,	87	a 75
		b 99.5
Felis onca,	87	a 87
Black and Tan Dog,	88.5	a 81
		b 96
Maltese cat,	89	a 89
Dasyprocta aguti,	90	a 90
Nasua rufa,	93	a 93
Cavia cutleri,	97	a 64
		b 73
		c 73
		d 79
		e 94
		f 103
		g 111
		h 112
		i 161
Lynx rufus,	98	a 98
Canis mesomelas,	101	a 101
Fox Terrier Dog,	109	a 100
		b 118
Putorius putor,	116	a 116
Helarctos malay,	117	a 117
Irish Terrier Dog,	130	a 130
Wild Rabbit,	137	a 132
		b 143
Erinaceus europ.,	140	a 140
Procyon lotor,	141	a 141
Retriever Dog,	145	a 145
Capreolus caprea,	150	a 149
		b 151
Domestic Rabbit,	151	a 151
Felis pardalis,	164	a 164
Cervus dama,	166	a 166
Trichosurus vulpec.,	172	a 172
Tayarsu tajac.,	194	a 194
Hystrix cristata,	197	a 197
Mus norvegicus,	209	a 209
Felis serval,	210	a 210
Lynx canad.,	215	a 215
Fiber zibeth.,	225	a 225
Belgian Hare,	231.5	a 193
		b 201
		c 202
		d 205
		e 224
		f 246
		g 285

II. Arrangement by Average of Relative Brain Weight.—*Continued.*

MAMMALS.

Species.	Proportion of Brain to Body. Aver. 1 to ...	Indvs. 1 to ...	Species.	Proportion of Brain to Body. Aver. 1 to ...	Indvs. 1 to ...
Belgian Hare,		*h* 296	Onychogale frenata,	*322*	*a* 322
Canis nubil.,	*251*	*a* 251	Tatu novemcinctus,	*328*	*a* 328
Sheep, merino,	*254*	*a* 254	Trichosurus fuligin.,	*342*	*a* 342
Ursus torquatus,	*260*	*a* 260	Thylacinus cynoc.,	*348*	*a* 348
Antilocapra amer.,	*265*	*a* 265	Sheep, Shropshire,	*352*	*a* 352
Ovis tragelaphus,	*271*	*a* 271	Felis concolor,	*353*	*a* 353
Macropus,	*276*	*a* 276	Ursus horribilis,	*382*	*a* 382
Odocoileus truei,	*288*	*a* 274	Capromys pilor,	*397*	*a* 344
		b 302			*b* 450
Petrogale,	*319*	*a* 296	Melursus ursinus,	*510*	*a* 510
		b 342	Alces americ.,	*669*	*a* 669

BIRDS.

Sporæginthus amand.,	*14.3*	*a* 13	Paroraria, sp.?	*25*	*a* 24
		b 15			*b* 26
		c 15	Bull Finch,	*26*	*a* 26
Leiothrix lutea,	*15*	*a* 15	Munia oryzivora,	*26.6*	*a* 22
Erithacus rubec.,	*15.5*	*a* 15			*b* 25
		b 16			*c* 28
Sylvia atricapila,	*17*	*a* 17			*d* 29
Munia malacca,	*19*	*a* 19			*e* 29
Parus,	*19*	*a* 19	Falco sparverius,	*27*	*a* 27
Gold Finch,	*21*	*a* 19	Corvus monedula,	*27*	*a* 27
		b 21	Paroaria cucullata,	*27.3*	*a* 25
		c 21			*b* 25
		d 24			*c* 26
Junco hyemalis,	*21*	*a* 21			*d* 27
Passer domestic,	*22*	*a* 22			*e* 27
Xanthura luxuosa,	*22*	*a* 19			*f* 27
		b 25			*g* 29
Paroaria larvata,	*22.7*	*a* 21			*h* 32
		b 23	Callopsittacus n. holl.,	*28*	*a* 28
		c 24	Brotogeris jugul.,	*29*	*a* 29
Megascops asio,	*23*	*a* 23	Zonotrichia albicol.,	*30*	*a* 30
Carpodacus purpur.,	*23*	*a* 23	Cardinalis cardin.,	*30*	*a* 30
Melopsittacus undul.,	*23.5*	*a* 20	Cyanocitta cristata,	*30*	*a* 30
		b 27	Alauda arvensis,	*31*	*a* 31
Serinus,	*23.9*	*a* 20	Munia ("weaver-bird")	*31*	*a* 28
		b 21			*b* 34
		c 22	Mimus polyglottus,	*32.3*	*a* 25
		d 23			*b* 35
		e 23			*c* 37
		f 23	Psittacus erithacus,	*36.5*	*a* 35
		g 24			*b* 38
		h 24	Agelaius phrenicus,	*37*	*a* 37
		i 25	Amazona panamensis,	*37.8*	*a* 35
		j 25			*b* 35
		k 25			*c* 36
		l 26			*d* 39
		m 27			*e* 44
		n 27	Amazona leucocephala,	*38.2*	*a* 31
Acanthis cannabina,	*24*	*a* 24			*b* 37
Melospiza cinerea melod.,	*24*	*a* 24			*c* 39
Rail,	*25*	*a* 25			*d* 41

II. Arrangement by Average of Relative Brain Weight.—*Continued.*

BIRDS.

Species.	Proportion of Brain to Body. Aver. 1 to ...	Indvs. 1 to ...
Amazona leucocephala,		*c* 43
Corvus brachyrhynch,	*45.7*	*a* 39
		b 41
		c 44
		d 47
		e 49
		f 54
Dacelo gigas,	*47*	*a* 47
Cacatua moluccensis,	*48*	*a* 48
Columbig allina,	*49.5*	*a* 48
		b 51
Sirnium varium,	*51*	*a* 46
		b 56
American Robin,	*53*	*a* 53
Merula merula,	*55*	*a* 55
Strix pratincola,	*56*	*a* 52
		b 60
Sturnella magna,	*59*	*a* 59
Nycticorax naevius,	*60*	*a* 60
Plegadis guarama,	*65*	*a* 65
Turtledove, common,	*67.5*	*a* 67
		b 68
Nyctea nyctea,	*68*	*a* 68
Aix galericulata,	*71*	*a* 71
Oxyechus vociferus,	*72*	*a* 72
Nettion carolin.	*74.25*	*a* 60
		b 66
		c 78
		d 89
Florida cærulea,	*77*	*a* 48
		b 106
Bubo virginianus,	*77.5*	*a* 70
		b 85
Botaurus lentiginosus,	*85.5*	*a* 73
		b 98
Ocyphaps lophotes,	*86*	*a* 86
Ice pigeon	*88*	*a* 87
		b 89
Buteo lineatus,	*90*	*a* 90
Ardea tricolor ruficollis,	*94*	*a* 94
Turtur risorius,	*104*	*a* 104
Colinus virginianus,	*106.1*	*a* 79
		b 80
		c 81
		d 84
		e 91
Colinus virginianus,		*f* 93
		g 95
		h 105
		i 106
		j 110
		k 110
		l 112
		m 112
		n 113
		o 116
		p 120
		q 138
		r 165
Domestic pigeon,	*108.5*	*a* 99
		b 118
Borasa umbellus,	*111*	*a* 111
Homer pigeon,	*116*	*a* 116
Anas obscura,	*118*	*a* 118
Lophortyx californicus,	*124*	*a* 124
Corvus brachyrhynchus,	*130*	*a* 130
(Domesticated)		*b* 130
Larus argentatus,	*132.5*	*a* 102
		b 163
"Pigmy Pouter" pigeon,	*133.3*	*a* 116
		b 121
		c 163
Tantalus loculator,	*138*	*a* 138
Phœnicopterus ruber,	*149.7*	*a* 147
		b 150
		c 152
Numidia cristata,	*155*	*a* 155
Anhinga anhinga,	*166.7*	*a* 132
		b 134
		c 234
Cathartes aura,	*205*	*a* 205
Golden Seabright Chicken,	*205.5*	*a* 118
		b 293
Ardea herodias,	*208.5*	*a* 201
		b 216
Aquila chrysætos,	*292*	*a* 292
Cygnus gilbus,	*304*	*a* 304
Cygnus olor,	*381*	*a* 381
Chicken,	*457*	*a* 325
		b 437
		c 609
Pavo cristatus,	*457*	*a* 457

BIBLIOGRAPHY

Ebel, J. G.

1788 Observationes neurologicæ ex Anatome comparata. Trai. ad Viad., 1788, p. 9 et seq., tab. I.

Cuvier, G.

1805 Leçons d'anatomie comparée. Paris, 1805, 9me Leçon.

Serres, E. R. A.

1827 Anatomie comparée du cerveau. Paris, 1827, I, 13 et seq.

Leuret et Gratiolet.

1857 Anatomie comparée du système nerveux. Paris, 1857, I, 249.

Owen, R.

1866 On the Anatomy of Vertebrates. London, 1866.

Brandt, A., jun.

1867 Sur le rapport du poids du cerveau à celui du corps chez différentes animaux. Bull. Soc. impér. naturalist de Moscow, 1867, No. 4, pp. 525–543.

Colin, G.

1886 Traité de physiologie comparée. 3me ed., Paris, 1886, I, 302–305.

Manouvrier, L.

1888 Sur l'interpretation de la quantité dans l'encephale et dans le cerveau en particulier. Bull. Soc. d'Anthropol. de Paris, 2me Ser., II–III, 137–323, 1888.

Kükenthal u. Ziehen.

1889 Das Centralnervensystem d. Cetaceen. Denkschr. d. med. naturw. Gesell. zu Jena, III, 124; Jena, 1889.

Hancock, J. L.

1890 The Brain Weight of Birds. Amer. Naturalist, Phila., 1890, XXIV, 969.

Mies, J.

1891 U. d. Gehirngewicht einiger Thiere. Verhandl. d. Gesellsch. deutsch. Naturf. u. Aerzte, 1890, Leipzig, 1891, LXIII, pt. I, 126–131.

Snell, O.

1891 Die Abhängigkeit d. Hirngewichtes v. d. Körpergewicht u. d. geistigen Fähigkeiten. Arch. f. Psychiatrie, 1891, XXIII, 436–446.

1891 Das Gewicht d. Gehirns u. d. Hirnmantels d. Säugethiere in Beziehung zu deren geistigen Fähigkeiten. Sitzb. d. Gesellsch. f. Morphol. u. Physiol., München, 1891, 1–5.

Keith, A.

1894-5 The Growth of Brain in Men and Monkeys, with a Short Criticism of the Usual Method of Stating Brain-Ratios. J. of Anat. and Physiol., XXIX, 1894–5, 282–303.

Weber, M.

1896 Vorstudien ü. d. Hirngewicht d. Säugethiere. Festschrift f. Carl

Gegenbaur, 1896, Leipzig, 1897, III, pp. 103–123; Verslag v. d. Vergadering d. Kon. Akad. van Wetenshappen te Amsterdam, van 31 Oct., 1896.

Dubois, E.

1897 Sur le rapport du poids de l'encéphale avec la grandeur du corps chez les mammifères. Bull. Soc. d'anthropol. de Paris, 1897, 4me S., VIII, 337–376.

Dubois, E.

1898 U. d. Abhängigkeit d. Hirngewichtes von. d. Körpergrösse bei den Säugethieren. Verhandl. d. Kon. Akad. v. Wetenschappen to Amsterdam, V, No. 10, April, 1897; Arch. f. Anthropol., XXV, 1898, pp. 1–28.

Brandt, A.

1898 Das Hirngewicht u. d. Zahl. d. peripherischen nervenfasern in ihrer Beziehung z. Körpergrösse. Biol. Centralbl., Leipzig, 1898, XVIII, 475–488.

Lapicque, L.

1898 Sur la relation du poids de l'encéphale au poids du corps. Compt. rend. soc. biol., Paris, 1898, 10 S., V, 62.

Ziehen, T.

1901 U. verglichend anatomische Gehirnwägungen. Monatschr. f. Psychiat. u. Neurol., Berlin, 1901, IX, 316–320.

Spitzka, E. A.

1903 Brain Weights of Animals, with Special Reference to the Weight of the Brain in the Macaque Monkey. J. Compar. Neurol., Granville, O., 1903, XIII, 9–17.

NOTES

Smithson Mortuary Chapel

An account of "The Removal of the Remains of James Smithson," by S. P. Langley, appeared in the Smithsonian Quarterly in April of last year.[1] As stated in the article, James Smithson, the founder of the Smithsonian Institution, died on January 27, 1829, at Genoa, Italy. He was buried in the little English cemetery on the heights of San Benigno, in a tomb which until recently bore no reference to him as the founder of the Institution which bears his name. When this cemetery was expropriated for municipal purposes by the Italian Government in 1903, the Regents determined to bring Smithson's remains to Washington. Doctor Alexander Graham Bell, the committee appointed for this purpose, was successful in his mission, and on January 25, 1904, formally gave the remains into the hands of the Regents.

The body, upon its arrival in Washington, was placed temporarily in a room in the Smithsonian building containing the relics of Smithson. While resting there, the remains were examined by medical experts and found to be in a remarkable state of preservation. Meanwhile a small mortuary chapel was prepared for them on the immediate left of the north entrance of the Smithsonian building, and on March 6, 1905, the remains were brought to this chapel and, in the presence of the Regents, replaced in the original tomb, shown in the illustration, where they will rest until Congress makes adequate provision for their fitting interment.

International Oriental Congress at Algiers, 1905

The following circular was distributed during the last week of February by the Institution:

Washington, D. C.,
February 20, 1905.

The Fourteenth International Congress of Orientalists will be held at Algiers, under the auspices of the Algerian Government, April 19–26, 1905. This Congress will be organized in seven sections: (1) Aryan (and other native languages of India), (2) Semitic (except Arabic), (3) Islamic (Arabic, Persian, Turkish), (4) Egyptian (African languages, including Madagascan), (5) The Far East, (6) Greece and the Orient, (7) African Archæology and Mohammedan Art.

[1] "The Removal of the Remains of James Smithson," by S. P. Langley, Smithsonian Miscellaneous Collections (Quarterly Issue), Volume xlv, No. 1449, April 11, 1904.

Papers on Oriental philology, archæology, history, geography, sociology, etc., may be presented in French, English, German, Spanish, Italian, Latin, or Arabic.

On April 23 and 24 two excursions will be made, one to Western Kabylia and the other to Shiffa (Gorge de Chiffa), Shershel, and Tipaza. After the Congress two tours will be conducted, one to Oran and the others to Tunis. The Western Caravan will go to Oran by way of Perregaux, visiting Ain-Sefra, Beni-Oonif, Figig, in the south; then Tlemcen, in the north (Sidi Boo Mediine, Sidi-Yakoob, Mansoorah). It will last eight days (April 27 to May 4) and cost about $22.00, including meals, lodgings, and transportation (except by rail). The Eastern Caravan will go to Tunis, visiting Biskra, Batna, Timgad, Constantine. This tour will last five days (April 27 to May 1) and will cost about $20.00, including meals, lodgings, and transportation (except by rail). Special excursions to Carthage, the Boo-Kornine, Kairooan, etc., at the rate of about $2.00 per day (except railroad tickets), will be arranged at Tunis, May 2–8.

The Algerian, Tunisian, French, and Italian railroads will allow the members of the Congress a reduction of 50 per cent. from April 10 to May 10. The Mediterranean lines between Marseilles and Algeria will grant a reduction of 30 per cent. (Adria Line, Fiume, 50 per cent.).

Cards of membership ($4.00 for men) entitle the holder to all the publications of the Congress, the receptions, fetes, etc., and reduced rates of transportation. Tickets for ladies, granting the same privileges, except copies of the transactions of the Congress, are issued at $2.00. It will be necessary to indicate the French railways by which the member of the Congress intends to go to Marseilles, and the European address to which the cards and certificates are to be sent.

Dr. Cyrus Adler, Librarian of the Smithsonian Institution, Washington, D. C., has been appointed the official representative in the United States of the Committee on Organization of the Congress. Blanks for application for membership and for transportation certificates, and circulars giving lists of sections, their respective Presidents and Secretaries, programs of excursions, may be obtained from him, and he will also receive and transmit payments for membership certificates and titles of communications to be presented to the Congress.

RECENT PUBLICATIONS OF THE SMITHSONIAN INSTITUTION

CONTINUED FROM LIST OF MAY, 1905, IN PUBLICATION No. 1559

No.	Title	Series	Price
1571	BROWNING, P. E. Index to the Literature of Indium, 1863–1903	M.C. XLVI	.05
1572	Smithsonian Miscellaneous Collections, vol. XLVI.	M.C. XLVI	
1573	Smithsonian Miscellaneous Collections (*Quarterly Issue*, vol. II), vol. XLVII	M.C. XLVII	
1574	Smithsonian Miscellaneous Collections, *Quarterly Issue*, vol. III, part I (containing 1575–1583) ..	M.C. XLVIII	.50
1575	MASCHA, E. The Structure of Wing Feathers (*Quarterly Issue*)	M.C. XLVIII	.10

DOOR TO SMITHSON MORTUARY CHAPEL, SHOWING IRON GATEWAY MADE FROM RAILING AROUND THE TOMB IN THE SAN BENIGNO CEMETERY, GENOA

INTERIOR OF SMITHSON MORTUARY CHAPEL

1576	GILL, THEODORE. The Tarpon and Lady-fish (*Quarterly Issue*)	M.C. XLVIII	.10
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1579	OBERHOLSER, H. C. Notes on the Nomenclature of Certain Genera of Birds (*Quarterly Issue*)	M.C. XLVIII	.05
1580	MCPIKE, E. F. The Bibliography of Halley's Comet (*Quarterly Issue*)	M.C. XLVIII	.05
1581	WHITE, C. A. The Ancestral Origin of the North American Unionidæ (*Quarterly Issue*)	M.C. XLVIII	.05
1582	HRDLICKA, ALÉS. Brain Weight in Vertebrates (*Quarterly Issue*)	M.C. XLVIII	.05
1583	Notes to Quarterly Issue, Volume III, Part I. Smithson Mortuary Chapel. Congress of Orientalists. List of publications	M.C. XLVIII	.05

VOL. 48 1905

SMITHSONIAN

MISCELLANEOUS COLLECTIONS

VOL. III QUARTERLY ISSUE PART 2

THE DIPLOMATIC SERVICE OF THE UNITED STATES WITH SOME HINTS TOWARD ITS REFORM[1]

BY ANDREW D. WHITE, LL.D., D.C.L.

REGENT OF THE SMITHSONIAN INSTITUTION, SOMETIME PRESIDENT OF CORNELL UNIVERSITY, MINISTER PLENIPOTENTIARY AT ST. PETERSBURG AND AMBASSADOR AT BERLIN

Remarks of Mr. S. P. Langley, Secretary of the Smithsonian Institution, introducing Doctor White.

A number of years ago Mr. James Hamilton left a small bequest to the Smithsonian Institution, the income of which was to be "appropriated biennially by the secretaries, either in money or a medal, for such contribution, paper, or lecture on any scientific or useful subject as said secretaries may approve."

The Regents of the Institution decided to let this small sum accumulate, and it is only recently that the Secretary has found himself able to commence to employ the income as a lecture fund.

The lectures may be on any scientific or useful subject, but surely no subject is more useful or important than that which tends to promote a general peace among mankind, and I am fortunate in being able to present to you to-day one who can speak with authority on the diplomatic service of our country, which has at all times signally and successfully aided in promoting this great object of the peace of the world.

I have now particular pleasure in introducing to you as the first lecturer in the series one whose name is so prominent in these annals of American diplomacy, as that of the Honorable Andrew D. White.

Mr. President, Ladies, and Gentlemen:

Some years since, a very eminent American journalist, in discussing our diplomatic service, proposed what he was pleased to

[1] An address delivered before the Smithsonian Institution at Washington, March 9, 1905.

call "a reform." His plan was exceedingly drastic. For it was nothing less than that the entire existing system be extirpated, root and branch,—in fact, "reformed off the face of the earth," and that in place of it, whenever our Government should have any business with any other, it should seek out a suitable agent, make a fair bargain with him for his services, send him to attend to the matter, and then recall him as soon as he had finished it.

Although this advice has often been cited as a piece of political wisdom, has lingered vaguely in the public mind, and has, indeed, been recently sanctioned by a very eminent American citizen, it seems not difficult to show that such a departure from the practice of the whole civilized world would be a misfortune,—not only to our country in general, but especially to our political, commercial and financial interests; that our guiding idea in any reform of the diplomatic service, as in every other true reform, should be, not revolution but evolution; not an adoption of the idea dear to so many so-called reformers, that "whatever is is wrong," but the recognition in our existing system of what is good, and the development out of this, by simple common sense and statesmanlike methods, of something better.

For, in view of all the interests of our country, ever extending, ever becoming more complex, ever demanding, more and more, quick sight and prompt action, what is it that we need? Is it men to be sought and selected and passed upon and haggled with and sent across the ocean to see if, perhaps, they can mitigate serious and even disastrous international trouble after it has got under full headway? Is it not, rather, to have thoroughly trained men on the spot, who shall foresee trouble, prevent it, attenuate it, disperse it, be in touch with the right men, know the right means, speak the right word, at the right moment, in the right quarter?

Some years since, at Constantinople, I asked the cause of the widespread conflagrations which had so often devastated that capital. The answer was that the city had a very peculiar fire department—that when a fire broke out in any house, the proper and usual way was for its owner to seek someone who owned a hand fire engine, to find, by proper examination, whether he was trustworthy, whether his helpers were robust, whether his fire apparatus was effective; and then to make a bargain with him and his helpers and conduct them to the fire. There was usually, so I was informed, not much trouble in finding the fire, for, by the time the machine had been approved and the firemen selected and bargained with and got to the spot, the conflagration was amply evident.

Whether this alleged method really existed or not among the Turks, it is certainly the sort of thing contemplated in the proposal I have just mentioned, regarding the beginnings of international conflagrations.

As a matter of historical fact, this system of special and temporary diplomatic agents was fully tried during the Middle Ages, with the result that for hundreds of years Europe was furrowed and harrowed with perpetual war, whereas the modern system, with all its defects, has come into existence by an evolution due to the environment of an ever increasing civilization, has certainly prevented very many germs of international trouble from developing, and has given the world long periods of peace.

Many examples might be mentioned, showing what can be done by the right man, saying the right word, at the right time, and in the right place, but I will remind you of just one, well known, as typical—that of Mr. Charles Francis Adams, our Minister to Great Britain during the most trying period of our Civil War. He was a very capable man, and was especially known as a very cool man. You may remember that one very hot summer, in Kansas, when great injury was done to cattle and crops by drought, various newspapers proposed that he should be sent for and asked to travel through the State in order to reduce its temperature.

A crisis had come in the relations of the United States and Great Britain. It looked much as if a number of additional cruisers, nominally American but really British, were to be let loose to prey upon our commerce. The British Minister of Foreign Affairs at that time was Earl Russell, a man whom Carlyle would have called "a solemnly constituted impostor"; and as he had not prevented the sailing of the previous cruisers, it did not seem likely that he would prevent the sailing of these. But, just as they were ready to depart on their mission of devastation, Mr. Adams wrote Earl Russell, stated the case very simply, and used these memorable words, "It would be superfluous in me to point out to your lordship that this is war."

This cool, plain, straightforward statement, made in the right manner, to the right man, at the right moment, stopped the cruisers, and war was prevented—immensely to the advantage of American commerce and of all the interests of our country.

For, of all the calamities to the world which one can imagine, there can hardly be anything more fearful than a war between the two great English speaking nations. Indeed, nothing could be worse, unless it were the relinquishment of international righteous-

ness, or the sacrifice of the just position of our country, or of the self-respect of its citizens.

A special reason for the maintenance of an organized diplomatic service is found in the need of making or modifying treaties. Here it is that a minister permanently residing at a foreign court has a decided advantage. He notes the progress of affairs, watches for oppportunities, makes the acquaintance of statesmen and other men of influence in the country to which he is accredited, and is thus able to suggest and to secure treaties and modifications of treaties much earlier and more easily than could possibly be done from the center of a distant government. Even if special commissioners be sent to make a treaty, a resident representative is sure to be of the utmost value.

An excellent example is seen in the late George Bancroft during his career as Minister of the United States at Berlin—a career which lasted about eight years.

Up to his time, Germans who had become American citizens and afterward revisited their own country were constantly liable to arrest or annoyance with reference to their military and other duties to the country of their birth: there was then a frequent assertion in all parts of Europe of the old principle, "once a subject, always a subject," and the result was very great hardship to large numbers of worthy men, great distress to many families, and constant danger of hostile relations between our own country and various German states; relations which might have resulted in serious injury to our manufactures and commerce, costing us in a few months a far greater sum than our diplomatic establishment would cost in many years.

In the struggle between Prussia and Austria, which led to the establishment of the North German Confederation, and in the resultant desire of Prussia for a friendly attitude of the United States, Mr. Bancroft saw his opportunity. He secured with much labor and skill, concessions which at any other time would have been withheld. The German government maintained that permission to German-Americans to return and remain in Germany had led to a wretched prostitution of American citizenship; that great numbers of young men, just about arriving at the military age, had no sooner been naturalized in the United States than they hurried back to their fatherland, claiming the privileges of both countries, but discharging the duties of neither. In the treaties now obtained, the right of the former subjects of various German states naturalized in our own country to revisit the place of their birth, was defined, and most

favorably to them. As a rule, they were allowed to return to the German Confederation freely and to remain there for two years, with the understanding that they should then make choice between the country of their birth and the country of their adoption. The whole sysem was thus made perfectly intelligible, preventing any further trouble, so long as Germany remained what it then was. Still more than that, as the great war between Germany and France drew on, Mr. Bancroft, being still on the ground, watching public affairs, saw that here was the opportunity to extend the treaties still further. This he did, and at last brought them upon an admirable footing, laying the foundations for permanent good will between the new Empire and the United States. He did this as no one could have done it without his experience in public affairs generally, and in German affairs specially, and certainly as no one could have done it unless upon the ground, carefully watching the progress of events, and skillfully making the most of them in behalf of his country. I may say, in passing, that the most amazing *tour de force* in his negotiations was his persuading both Prince Bismarck and himself that one basis of his claim for a better treaty was a striking similarity between the new constitution of the North German Confederation and the constitution of the United States. Never was a conviction less founded or more opportune.

Still another advantage of having a resident representative is that of creating an atmosphere in which the germs of international trouble are kept from developing, and in which troublesome questions between his own nation and that to which he is accredited may be easily settled. The French have a well-worn proverb, but a proverb which wears as well to-day as ever: " Absent people are always in the wrong." (*"Les absents ont toujours tort."*) English speaking peoples have another, much to the same effect: " The man I don't like is the man I don't know."

A representative of the United States, fitted for his place, at any important capital, finds, at various receptions, evening gatherings, festivities, official and unofficial, the ministers and leading men in the Government to which he is accredited, men of influence in executive departments, in parliament, in the press, and in social circles; and in this atmosphere learns beforehand of matters likely to create trouble, and is able to avert difficulty. By a word in the proper quarter, he can thus easily take the life out of whole flocks of *canards* let loose into the political atmosphere by men engaged in stock-jobbing or sensation mongering. So, too, a minister frequently receives, from this friend in public service or that friend in society,

hints regarding questions likely to arise, or information which it is desirable to have, in the interest of his own country.

Among typical examples of men who have served our country admirably in this way, in days gone by, are such as Elihu B. Washburne at Paris during the most critical moments of the Franco-Prussian War, the Invasion, and the Commune.

Typical also, in a very different way, was George P. Marsh, first at Constantinople, and afterward in Italy, at the formation period of the present Italian kingdom. In his quiet way, he prevented no end of difficulties, first throughout the Levant and later along the whole Northern coast of the Mediterranean.

Mention may also here be made of the late Henry Shelton Sanford. Though a minister to one of the smaller European powers, he became one of Secretary Seward's most valuable representatives in Europe during our Civil War, and did much, both by direct political and by well arranged social means, to ascertain the tendency of leading European statesmen and to influence them favorably toward American ideas and interests during that most critical period.

It is in this field that the statesmanship of Great Britain has shown its wisdom. Our mother country has by no means been a popular nation in the world. She seems to have preferred the respect of the world to its love; she has been at times too aggressive to be pleasing; but no one can deny that the way in which that little group of islands has baffled great despots like Louis XIV., Napoleon, and Nicholas I., has brought hundreds of millions beneath its sway, and has stretched its sceptre over every continent, without giving up its own constitutional liberty, is one of the wonderful things in human history. Whether we like it or not, we cannot but respect it. Yet a main factor in the accomplishment of this result is found not merely in the fleets and armies of Great Britain, but in the common sense of her diplomacy. As a rule, she has taken pains to send thoroughly fitted men into important diplomatic positions and to keep them there as long as they have done well. More than this, she has supplied them with the means to do their work: she has not stinted them; and the common sense of the English people is seen in the fact that at the great capitals of the world where her influence is to be exercised, she has always a large, commodious, and attractive residence for her representative, and makes his remuneration such that he can afford to devote all his thoughts to her interests. The demagogue may denounce this sort of thing; the doctrinaire may pooh-pooh it; but the fact remains that humanity,

as it is really constituted, is largely influenced in what are known as social ways, and for these Great Britain has always made abundant provision. Her embassy or legation in every capital of the world is a center, and generally a most influential center. Men may declaim against her; may even detest her, but, none the less, in every capital her embassy or legation stands as a power, social, and, largely on that account, political.

Another duty of our foreign representatives is the collection of information bearing on large questions important to our country. Of this information, that which relates to the actions of foreign powers in anticipated crises is frequently of the utmost importance. Grant that our diplomats have not the prophetic gift, still at every time since the formation of this Government, and never more than now, it has been of great importance to this country, politically and commercially, to have, at various centers of information throughout the world, thinking men with access to the best sources of news, who can constantly keep the home government advised as to the probable action of foreign powers. At this moment, when Europe is one great group of fortified camps, and great changes are taking place in Asia and Africa, and troublesome questions are arising in South America, it cannot but be of immense value to our manufacturing, commercial, and indeed all other interests to have the best and most recent information regarding the outcome of warlike operations, the drift of public opinion, and settlements likely to be made; and such information is obtained by our representatives at the lesser capitals almost as frequently as at the greater.

Then, too, there are other subjects of importance. Every year our State Department issues sundry volumes entitled "Diplomatic Relations." These are made up of selections from the dispatches of our representatives abroad. Among these are found not only dispatches on current international business, but valuable reports on leading subjects of public interest; and of these I may mention, in recent times, reports on systems of finance in foreign countries; on their supply and management of the circulating medium; on the administration of cities; on government railway systems; on public museums; on educational institutions; and the like. It may be said that the newspapers and magazines give us these; but the difficulty is that information thus supplied is too frequently sketchy and scrappy. I do not underrate the newspaper correspondent; he is one of the wonders of the world; but, after all, the diplomatic representative has certain decided advantages: he has easy access to men controlling every sort of institution, he can ask for interviews,

information, documents and the like with every probability of obtaining them, and this is not the case with the great majority of unofficial persons.

The social intercourse to which I have referred also affords a special means of casually obtaining important facts which one outside the diplomatic circle cannot reach.

The "Diplomatic Relations of the United States" are a great depository of information of all sorts, and are becoming more and more valuable. In proof of this assertion I would gladly refer to the despatches of many recently or at present in active diplomatic life; but, as that might seem invidious, I may at least say that a large number of them are models of wise observation, clear statement, and cogent reasoning. Any one looking over the main dispatches of our representatives abroad will see that their positions are not mere sinecures, but full of earnest and lucid thought for the highest interests of their country.

Another duty of a foreign representative of our country is to protect Americans within the country to which he is accredited. No doubt there are many in our own land who care little for this: it is very easy to say in an off-hand way, that if people go abroad as missionaries or for business, health or pleasure, they must take their chances; but as civilization has developed there has been evolved a better feeling which I trust may become deep and permanent throughout the country, and that is, that our citizens are to be fully protected in all parts of the world, at any cost. The famous boast "I am a Roman citizen," which was the passport and armor of the Roman in any part of the world, gives the idea of what ought to be the claim of the American citizen. Our own history in this respect has at times been creditable to us, but here, too, our mother country sets the world an example. Let any British subject in any part of the world be maltreated, and immediately it is a matter of interest to the home government. The resident minister feels himself false to his duty, or, if he deos not feel so, knows that he will surely be denounced by the press and in Parliament, if he be remiss in securing redress for any wrong thus committed.

The most striking example of this, which now occurs to me, took place in the early part of this century in Lower Italy. An English gentleman and his wife were on their way from Naples to the ruins of Paestum. Having stopped over night at a town on the way, they took from their traveling carriage a dressing case in which the utensils were of silver, and this fact having been communicated from the servants at the inn to the neighboring brigands, these robbers on

the following day stopped the Englishman's carriage and demanded his " silver chest." The Englishman did not at first know what was meant, but presently it occurred to him, and he stooped to take out the case and hand it to the brigands; when, thinking that he was stooping to get his weapons, they fired into his carriage, killing him and his wife. Many countries would have contented themselves with the profuse palaver with which the Neapolitan Government tried to cover the matter, but such was not the case with the government of Great Britain. Not long afterward a frigate bearing the British flag sailed into the harbor of Naples, and the British minister made a formal demand. The immediate result was that eighteen brigands were hanged and the final result was that for a long time afterward, whomever brigands along the Mediterranean might murder, they very carefully spared Englishmen.

But here I wish to do what is possible for me, toward putting to rest a calumny against our own country as to the protection of her adopted citizens abroad. It has not infrequently been stated that Great Britain and various other countries are more careful in guarding the interests of their adopted citizens than is the case with our own Government. The very contrary is the truth. The rule in most, if not all, other countries, and especially in Great Britain, is to protect the interests of their adopted citizens in all other countries save that of their birth; but to leave them, when visiting their native country, to the tender mercies of that country. The rule of Great Britain is that when a naturalized subject visits the land of his birth, he does so at his own risk and peril. The American Government, on the other hand, exerts itself to the utmost to protect its adopted citizens in the land of their birth. Our country has taken the greatest possible pains to make careful treaties for this purpose, and in nothing has she been more constantly strenuous than in seeing that there be no infraction of such treaties. For many years it seemed to be the main business of American representatives abroad to struggle for the interests of our adopted citizens against every possible construction of treaties which might in any way curtail their interests. Any person looking at what are known as the " budget dispatches " from our embassies abroad will see most ample proofs of this.

And here a tribute ought not to be omitted to our recent and, indeed, present Ministers to Turkey and China:—a long series of them in both these regions have done their duty nobly.

Still another of the functions of an American diplomatic representative is to cooperate with the consuls of his government, promot-

ing by all honorable means the interests of American agriculture, manufactures, and commerce. The value of this kind of service was amply shown by the late Townsend Harris, in Japan. Having been sent to that country by President Peirce and Secretary Marcy, as Consul General, he was afterward given the powers of a special envoy, and finally promoted to the position of a Minister Resident. To him, more than to any other man, is due the opening of Japan to the commerce of America and of the world. His high character and skill inspired a confidence which enabled him to make that great treaty which marks a new point of departure in modern civilization. The value of the diplomatic service to commerce was also shown more recently by the successful efforts of our ministers, Mr. Reid at Paris and Mr. Phelps at Berlin, in breaking the European barriers hitherto maintained against some of the principal products of American agriculture.

And, finally, perhaps the highest incidental work in which a diplomatist can engage is the development of international law.

The Law of Nations is not made; it grows,—and in many ways; among others, by the labors of men employed in making treaties, or in conducting negotiations between different governments. The development of international law since the great work of Grotius in the seventeenth century is one of the noblest things in human history. In no field, perhaps, has so much been done to diminish unmerited suffering. Among those who have taken noble part in it are such as Franklin, Jefferson, John Adams, Jay, and, in more recent times, Wheaton, Dana, Lawrence, Bancroft, and Schenck. Of these, Henry Wheaton, who represented the United States from 1827 to 1846 at Copenhagen and Berlin deserves special mention. His works on International Law have become classics,—held in high honor at Oxford and Cambridge, at Paris and London, and even at Pekin, where his principal work has received the honor of a Chinese translation.

Nor is this good development by any means ended. It may be within the power of any diplomatist, at any time, to exert a controlling influence in favor of arbitration between states which might otherwise be plunged into war, and thus to promote the substitution of arbitration for war in the gradually strengthening code of International Law.

And there is yet another great principle to be pressed upon the world, and an especially American principle. I refer to the exemption from seizures on the high seas of private property, not contraband of war. This is one of those great, steady, efforts for the

evolution of right reason, of mercy, and of a higher civilization which has been urged by American diplomatists steadily and on every possible occasion, from the days of our famous treaty with Frederick the Great, down to these times, when the American Delegation at the Hague Peace Conference has secured a place for discussion of this great subject on the programme of the next general conference of the civilized world.

In view of these great possibilities for a better future to the various nations and to universal humanity, there is no more promising field for fruitful effort than the American diplomatic service; —when it shall have been properly reorganized.

Hence it is, especially, that every thinking lover of his country must look with longing to the day when there shall be in all our leading universities young men in training for that service.

The first argument of those who declaim against any permanent diplomatic service or who would keep it in its present state of arrested development is that it is costly. But I think that you will see in it, really, " the cheap defense of nations." The loss by a misunderstanding, which would bring injury upon American commerce, or by a failure to secure speedy information which would enable us to protect our interests in a foreign war, might be greater than the cost of our diplomatic establishment for many years. The loss by a war, which might have been averted by a well trained diplomatist on the ground, might be far more than enough to maintain the whole diplomatic corps of the United States for decades if not for centuries.

As a matter of fact, the entire annual appropriation for the diplomatic service of the United States during each of several recent years has been about $500,000, but the cost of military and naval operations during our Civil War was, to the United States, between one and two millions for each day. The cost of military operations during the Franco-Prussian War, if divided equally between the two nations, would have amounted each day, for each, to considerably more than $3,000,000. It is clear then that, even if war, with all its improved methods, should cost no more than it did thirty years ago,—which is a decidedly violent supposition,—the entire expenditure for our diplomatic corps for one year would be only about the expenditure for war during four hours; and if, which may Heaven forbid, we should be so unfortunate as to have a war break out with any foreign power, our diplomatic service would pay for itself during about six years, if it shortened the war by a single day. It is altogether probable that Mr. Charles Francis Adams, by his timely words to Earl Russell, prevented a prolongation of

our Civil War, which would have cost us more than the entire diplomatic service during centuries.[1]

It is also urged that residence abroad makes men " un-American." This is one of those vague charges to which a thinking man will generally attribute little importance. But even if there were some truth in it, as regards an ill balanced individual here and there, there can be set against it a more than countervailing advantage, which is, that our diplomatic service sends abroad, for a term of years, citizens from various parts of the country, who, after discharging their duties abroad, return with valuable experience to various stations at home—some like the Adamses, Jefferson, Monroe, Van Buren, and Buchanan, carrying their experience into the Chief Magistracy; some, like those just named, and Marshall, Clay, McLane, Forsythe, Legaré, Everett, Cass, Bayard, Foster, and Hay, into the Secretaryship of State; some into other Cabinet places; some into either house of Congress; some into the press; and some into other positions which give opportunities for enlightening influence upon public opinion.

And it is sometimes said, in the jaunty, off-hand way, so often used in dealing with important questions, that the diplomatic service is, after all, mainly recreation. Any American representative who goes abroad with this idea will soon find that he has made a serious mistake. A minister or secretary who does his duty, finds his leisure absolutely eaten up by multitudes of international matters, some large, some small, but all demanding attention. Were there time, I could give abundant examples of this. There is in every American embassy and legation a constant succession of matters requiring constant vigilance and the judicious exercise of firmness and conciliation.

Even what is called recreation is frequently hard work. I remember a dispatch from Mr. Lowell, in which, alluding to the fatigue of a great court function, he said that he relied upon it to make up in another world for a multitude of his sins in this. Many a diplomatist has had occasion to remember the remark that " life would be tolerable were it not for its pleasures."

And now, as to the present condition of the American diplomatic service. It is in many respects excellent; but it is badly organized,

[1] A century of our diplomatic service, at its present rate, would cost about fifty millions of dollars. A year's prolongation of our Civil War, by the interference of Great Britain, would have cost us, reckoning nothing for the increased expenditure to meet British hostilities, one thousand millions at least.

insufficiently provided for, and, as a rule, has not the standing which every patriotic American should wish for it. And yet it could easily be made one of the best, and quite possibly the best, in the world. The most essential and desirable improvements which I would present are, in a general way, as follows:

I. As regards the highest grade in the diplomatic service, that of Ambassadors, I would have, say, one-half their number appointed from those who have distinguished themselves as Ministers Plenitopentiary, and the remaining posts filled, as at present, from those who, in public life or in other important fields, have won recognition at home as men fit to maintain the character and watch the interests of their country abroad. And as to this highest rank, I would observe, as regards, say, one-half those holding it, the general rule of promotion for good service, and from the less important to the more important capitals.

II. As regards the second grade in the service—namely, that of Ministers Plenipotentiary—I would observe the same rule as in appointing Ambassadors, having, say, one-half of these at the more important capitals appointed for such as have especially distinguished themselves at the less important capitals, and, say, one-half of the Ministers Plenipotentiary at these less important capitals appointed from those who have distinguished themselves as Ministers Resident, or as Secretaries of Embassy or of Legation.

III. As to the third grade in our service, that of Ministers Resident, I would observe the general rule above suggested for the appointment of Ambassadors and Ministers Plenipotentiary; that is, I would appoint one-half of them from among those who shall have rendered most distinguished service as first Secretaries of Embassy or of Legation. When once appointed I would have them advanced for distinguished service from the less to the more important capitals, and, as far as possible, from the rank of Minister Resident to that of Minister Plenipotentiary.

IV. As to any lower, or special, or temporary grades, whether that of Diplomatic Agent, or special Chargé d'Affaires, or Commissioner, I would have appointments made from the diplomatic or consular service, or from public life in general, or from fitting men in private life, as the President or Secretary of State might think most conducive to the public interest.

V. I would have two grades of Secretaries of Legation and three grades of Secretaries of Embassy. I would have the lowest grade of secretaries appointed on the recommendation of the Secretary of State from those who have shown themselves, on due examina-

tion, best qualified in certain leading subjects, such as international law, the common or civil law or both, including, as absolutely necessary, some practice in one or the other of these, the history of treaties, general modern history, political economy, a speaking knowledge of French and a reading knowledge of at least one other foreign language.

As to the practice of the law, I would demand that every candidate should have been admitted to the bar and have been in practice at least two years. You ask, perhaps, why I lay such stress on the actual practice of the law. My reasons are two. First, in the interest of the service, I wish every Secretary to have been in touch with real men and real activities. Secondly, in the interest of the candidates, I do not wish to see a diplomatic proletariate. Bear in mind that the number of candidates for a regularly organized service would doubtless be large, and that the number to be appointed is small. Without this practical requirement we should have great numbers of ingenuous youth left with no occupation save cursing the unfitness of the Secretary of State or the stupidity of the examiners: *with* this requirement, the rejected would simply pursue the even tenor of their profession—all the better fitted for it by their diplomatic studies.

I would make the examination in all the above subjects strict, and would limit the selection of Secretaries of Legation and Embassy to the men thus presented. But, in view of the importance of various personal qualifications which fit men to influence their fellowmen, and which cannot be ascertained wholly by examination, I would leave the Secretary of State full liberty of choice among those who have honorably passed the examinations above required. The men thus selected and approved I would have appointed as Secretaries of the lower grades—that is, Third Secretaries of Embassy and Second Secretaries of Legation—and these men when once appointed should be promoted for good service, to the higher secretaryships of Embassy and Legation, and from the less to the more important capitals, under such rules as the State Department might find most conducive to the efficiency of the service. No new Secretaries of any grade should thereafter be appointed who had not passed the examinations required for the lowest grade of secretaries as above provided; but all who had already been in the service during two years should be eligible for promotion for good service, from whatever posts they might be occupying.

VI. I would attach to every Embassy three secretaries, to every Legation two, and to every post of Minister Resident, at least one.

One of the thoroughly wise arrangements of every British Embassy or Legation—an arrangement which has gone for much in Great Britain's remarkable series of diplomatic successes throughout the world—is to be seen in her maintaining at every capital a full number of Secretaries and Attachés. These serve, not only in keeping the current office work in the highest efficiency, but become, as it were, the *antennæ* of the ambassador of Minister—additional eyes and ears to ascertain what is going on among those most influential in public affairs. Every Embassy or Legation thus equipped serves also as an actual and practical training-school for the service.

VII. I would appoint each Attaché from the ranks of those especially recommended and certified to in writing by leading authorities in the department for which he is expected to secure information: as, for example, Political Attachés by the State Department; Military Attachés by the War Department; Naval Attachés by the Navy Department; Financial Attachés by the Treasury Department; Commercial Attachés by the Department of Commerce; Agricultural Attachés by the Department of Agriculture; but always subject to the approval of the Secretary of State as regards sundry qualifications, hinted at above, which can better be ascertained by an interview than by an examination.

I would have a goodly number of Attachés of these various sorts, and, in our more important Embassies, one representative from each of the departments above named. Every Attaché, if fit for his place, would be worth far more than his cost to our government, for he would not only add to the influence of the Embassy or Legation, but to its efficiency. As a rule, all of them could also be made of real use after the conclusion of their foreign careers: some by returning to the army or navy and bringing their knowledge to bear upon those branches of the service; some by taking duty in the various departments at Washington, and aiding to keep the government abreast of the best practice in other countries; some by becoming professors in universities and colleges, or writers for the press, thus giving us, instead of loose guesses and haphazard suggestions, information based on close knowledge of international problems and of their solution in countries other than our own.

From these arrangements I feel warranted in expecting an evolution of better out of present good in our diplomatic service. Thus formed, it would become, in its main features, like the military and naval services, and, indeed, in its essential characteristics as to appointment and promotion, like any well organized manufacturing

or commercial establishment. It would absolutely require ascertained knowledge and fitness in the lowest grades, and it would give promotion for good service from first to last. Yet it would not be a cast iron system. For, it would admit and might well be construed to require the appointment of fully half of the Ambassadors, Ministers Plenipotentiary, and Ministers Resident from those who have shown decided fitness in high public positions at home, whether in important branches of public or private business, whenever the President should deem that the public interest requires it.

But the system thus proposed, while allowing the frequent bringing in of new and capable men from public life at home, requires that one-half of all representatives in each grade above that of Secretary (save certain special Diplomatic Agents, Special Commissioners, and the like), shall be appointed from those thoroughly trained for the service; and that all Secretaries, without exception, shall be thoroughly trained and fitted. Scope would thus be given to the activity of both sorts of men, and the whole system made sufficiently elastic to meet all necessities.

In the service thus organized, the class of Ambassadors and Ministers fitted by knowledge of public affairs at home for important negotiations abroad, but without experience in diplomatic life or in foreign usages and languages, would be greatly strengthened by Secretaries who had passed through a regular course of training and experience. An American diplomatic representative without diplomatic experience, on reaching his post, whether as Ambassador or Minister, would not find—as was once largely the case—Secretaries as inexperienced as himself in diplomatic business, but men thoroughly prepared to aid him in the multitude of minor matters, ignorance of which might very likely cripple him as regards very important business: Secretaries so experienced as to be able to set him in the way of knowing, at any court to which he is accredited, who are the men of real power, and who mere parasites and pretenders; what relations are to be cultivated and what avoided; which are the real channels of influence, and which mere illusions leading nowhither. On the other hand, the Secretaries thoroughly trained would doubtless, in their conversations with a man fresh from public affairs at home, learn many things of practical use and be kept in closer touch with American ideas and affairs.

Thus, too, what is of great importance throughout the entire service, every Ambassador, Minister Plenipotentiary, or Minister Resident would possess, or easily command, large experience of various men in various countries. At the same time, each representative

would be under most powerful incentives to perfect his own training, widen his acquaintance, and deepen his knowledge—incentives which, under the old system—with its lack of appointment for ascertained fitness, lack of promotion for good service, and lack of any certainty of tenure—exist very rarely if at all.

The system of promotion for merit throughout the service is no mere experiment; the good sense of all the leading nations of the world, except our own, has adopted it, and it works well. In our own service the old system works badly. For excellent men, both in its higher and lower grades, have been frequently crippled by want of proper experience or aid. We have, indeed, at this moment several admirable Secretaries—some of them fit to be Ambassadors or Ministers—but all laboring under conditions the most depressing—such as obtain in no good business enterprise. During my stay as Minister at St. Petersburg, the American Secretary of Legation, a man ideally fitted for his post, insisted on resigning. On my endeavoring to retain him, he answered as follows: "I have been over twelve years in the American diplomatic service as Secretary; I have seen the Secretaries from other countries, with whom I began my diplomatic career promoted until all of them still remaining in the service are in higher posts, several of them Ministers, and one an Ambassador. I remain as I was at the beginning, with no promotion and no probability of any. I feel that, as a rule, my present colleagues, as well as most officials with whom I have to do, seeing that I have not been advanced, look upon me as a failure. They cannot be made to understand how a man who has served so long as Secretary has been denied promotion for any reason save inefficiency. I can no longer submit to be thus looked down upon, and I must resign."

But here it ought to be acknowledged that various recent administrations have taken steps toward a system of promotion in our diplomatic service; and the present administration, more broadly and logically than any other.

While thus adopting a system of promotion based upon efficiency, I would retain during good behavior, up to a certain age, the men who have done thoroughly well in the service. Clearly, when we secure an admirable man,—recognized as such in all parts of the world,—like Mr. Wheaton, Mr. Bancroft, Mr. Charles Francis Adams, Mr. Marsh, Mr. Townsend Harris, Mr. Washburne, Mr. Lowell, Mr. Bayard, Mr. E. J. Phelps, Mr. Walter Phelps, and others who have passed away, not to speak of many now living, we should

keep him at his post as long as he is efficient, without regard to his politics. This is the course taken very generally by other great nations, and especially by our sister republic of Great Britain (for Great Britain is simply a republic with a monarchical head lingering along on good behavior) ; she retains her representatives in these positions, and promotes them without regard to their party relations. During my first official residence at Berlin, although the home Government at London was of the Conservative party, it retained at the German capital, as Ambassador, Lord Ampthill, a Liberal; and as first Secretary, Sir John Walsham, a Tory. The same indifference to party claims was evident at St. Petersburg during my two residences there, and at Berlin during my stay just closed. From every point of view, the long continuance, in diplomatic positions, of the most capable men would be of great advantage to our country.

But, as the very first thing to be done, whether our diplomatic service remains as at present or be improved, I would urge, as a condition precedent to any thoroughly good service, that there be in each of the greater capitals of the world at which we have a representative, a suitable embassy or legation building or apartment, owned or leased for a term of years by the American Government. Every other great power, and many of the smaller nations, have provided such quarters for their representatives, and some years ago President Cleveland recommended to Congress a similar policy. Under the present system the head of an American Embassy or Legation abroad is at a wretched disadvantage. In many capitals he finds it at times impossible to secure a proper furnished apartment; and, in some, very difficult to find any suitable apartment at all, whether furnished or unfurnished. Even if he finds proper rooms, they are frequently in an unfit quarter of the town, remote from the residences of his colleagues, from the public offices, from everybody and everything related to his work. His term of office being generally short, he is usually considered a rather undesirable tenant, and is charged accordingly. Besides this, the fitting and furnishing of such an apartment is a very great burden, as regards trouble, expense and time. Within my knowledge, two American Ministers abroad have impoverished their families by expenditures of this kind, and, without doubt, there have been many others. But this is not the worst. The most serious result of the existing system concerns our country. It is within my personal knowledge that in one very important international question our mistaken policy in this

respect recently cost the United States a sum which would have forever put that embassy on the very best footing,—as regards a permanent official residence. If an American Ambassador is to exercise a really strong influence for the United States as against other nations, he must be properly provided for as regards at least his residence;—not provided for, indeed, so largely as some representatives of other nations, for I neither propose nor desire that the American representatives shall imitate the pomp of certain Ambassadors of the greater European powers;—but he ought to be enabled to live respectably and discharge his duties efficiently. There should be, in this, what Thomas Jefferson acknowledged in the Declaration of Independence as a duty,—"a decent respect to the opinions of mankind." The present condition of things is frequently humiliating,—and not only to the Ambassador or Minister, but to every thoughtful American traveller. In the greater capitals of Europe the general public know the British, French, Austrian, Italian, and all other important Embassies or Legations, except that of our country. The American Embassy or Legation has no settled home, is sometimes in one quarter of the town, sometimes in another;—sometimes almost in an attic, sometimes almost in a cellar;—generally inadequate in its accommodations, and frequently unfortunate in its surroundings. Personal experience in various European capitals has shown me that one secret of the great success of British diplomacy in all parts of the world is that especial pains are taken regarding this point, and that, consequently, every British Embassy is the center of a widespread social influence which counts for very much indeed in its political influence. The United States, as perhaps the wealthiest nation in existence,—a nation far reaching in the exercise of its foreign policy, with vast and increasing commercial and other interests throughout the world,—should, in all substantial matters, be equally provided for. Take our relations with Turkey. We have constantly a vast number of Americans of the very best sort, and especially missionaries, teachers, and men of business, who have to be protected throughout the whole of that vast empire. Each of the other great powers provides for its representative at Constantinople a residence honorable, suitable, and within a proper enclosure for its protection; but the American Minister lives anywhere and everywhere,—in such premises, over shops and warehouses, as can be secured,—and he is liable, in case of trouble between the two nations, to suffer personal violence and to have the house sacked by a Turkish mob. No foreign people, and least of all an Oriental people, can highly respect a diplomatic representative who, by his

surroundings, seems to them not respected by his own people. The American Government can easily afford the expenditure needed to provide proper houses or apartments for its entire diplomatic corps, but it cannot afford *not* to provide these. Full provision for them would not burden any American citizen to the amount of a Boston biscuit. Leaving matters in their present condition is in the long run far more costly.

It seems incontestable that our diplomatic service ought not to be left in its present slipshod condition. It ought to be put on the best and most effective footing possible, so that, everywhere, the men we send forth to support and advance the manifold interests of our country shall be thoroughly well equipped and provided for. But whether the system I have indicated be adopted or not, whether salaries be increased or not, the permanent possession of a suitable house or apartment in every leading capital is absolutely the foremost and most elementary of necessities. And, in order to free my mind, I will add that, while the provision for a proper embassy or legation building is the first of all things necessary, it might also be well to increase somewhat the salaries of our representatives abroad. These may seem large even at present; but the cost of living has greatly increased since they were fixed, and the special financial demands upon an Ambassador or Minister at any of the most important posts are always far beyond the present salary. It is utterly impossible for an American diplomatic representative to do his duty on the salary now given, even while living on the most moderate scale known in the diplomatic corps. To attempt to do so would deprive him of all opportunity to exercise that friendly, personal, social influence which is so important an element in his success.

To sum up my suggestions as to this part of the subject, I should say: First, and foremost, as essential, that there be provided, at each diplomatic post where the United States has a representative, a spacious and suitable house or apartment, either bought by our Government or taken on a long lease. Secondly, as highly desirable, that American representatives of all grades should have their salaries increased by from twenty-five to fifty per cent. Thirdly, that an additional number of Secretaries and Attachés should be provided in the manner and for the reasons above mentioned.

Even if the carrying out of these reforms should require an appropriation to the diplomatic service sixty per cent. higher than it now is, which is an amount greater than, in my opinion, would be really required by all the expenditures I propose, including interest

upon the purchase money of appropriate quarters for our representatives abroad,—the total additional cost to each citizen of the United States would be but a trifle over one-quarter of one cent per year.

As to suitable requirements for secretaryships, and proper promotion throughout the whole service, they would vastly increase its attractiveness, in all its grades, to the very men whom the country most needs. They would open to young men in our universities, colleges, and schools of all grades a most honorable career leading such institutions to establish courses of instruction with reference to such a service—courses which were long since established in Germany, but which have arrived nearest perfection in two of our sister republics—at the University of Zurich in Switzerland, and in the *Ecole Libre des Sciences Politiques* in Paris.

And now, a few words in conclusion. You will have observed that my attempt has been to develop my subject in the simplest manner possible. I have carefully avoided the profounder questions connected with the subject: discussions of present and future American policy and the like, for the reason that I have wished to give merely those elementary considerations which may enable any American citizen to draw from them a straightforward conclusion as to things fundamentally necessary.

A word also in self-defense. My own connection with the foreign service of the United States has extended over fifty years, during which at various periods and posts, I have discharged diplomatic or quasi-diplomatic duties. In speaking of the defects of our present system and their remedies, I would above all things wish it to be understood that I am not a man with a grievance—that I have no complaints to make, whatever. On the contrary, I feel profoundly gateful to the various administrations—of both parties—under which I have served, for their support and kindness. This paper is the result of a decision made many years ago, that after the conclusion of my connection with the diplomatic service—when no human being could charge against me a desire to do anything for my own personal comfort or satisfaction—I would present, in the simplest and clearest manner possible, my view of the best course to be taken in developing and improving our diplomatic establishment—in the interest of our country; and in no other interest whatever.

It seems to me certain that a proper development of the existing service, on the general lines I have presented, would not only increase the prestige and influence of the United States among her sister nations, but, purely from a commercial point of view, would amply

repay us. To have in diplomatic positions at the various capitals a large proportion of men thoroughly fitted, not only as regards character and intelligence, but also as regards experience and acquaintance, and to have them enabled to exert their abilities under the best conditions, would be, from every point of view, of the greatest advantage to our country, materially and politically, and would give strength to our policy throughout the world.

WASH DRAWING OF RHINODON STRANDED ON COAST OF FLORIDA, MADE FROM THE SKIN AND PHOTOGRAPHS BY MR. A. H. BALDWIN

THE HISTORY OF THE WHALE SHARK (RHINODON TYPICUS SMITH)

By BARTON A. BEAN

In the month of April, 1828, there was captured by fishermen in Table Bay, Cape of Good Hope, one of the most interesting of living animals, being remarkable not only for its unusual structure but for the huge size it attains. The whale shark unlike other sharks has a terminal mouth, and the jaws are provided with ribbon-like dental plates of extremely numerous and minute teeth. This shark is said to grow to a length of sixty feet and is exceeded in size by no living animal other than the whale-bone or right whale. As Dr. Gill has expressed it to the writer it is: " The greatest, the most gigantic, of the sharks, not uncommon in the Indian Ocean, but which, on account of its great size, is represented by remains in few museums and is but little known."

This huge animal, like its relative of the north—the basking shark—and like the whale, lives on minute animals such as copepods, other crustaceans, and mollusks, which flourish in great abundance about the surface of the ocean. We find nothing recorded as to its manner of reproduction, but assume that like its related forms it is ovoviviparous. It is a slow moving, apathetic shark, harmless to man, and is often found basking or sleeping on the surface of the sea. It is known in the Indian Ocean as "Mhor," at the Seychelles as " Chagrin," in the Gulf of California as " Tiburon Ballenas " or whale shark, in the Gulf of Panama the natives call it " tintoreva," and the one stranded on the coast of Florida was referred to as an " East Indian basking shark."

We find little recorded as to the use made of this gigantic shark. In a letter on shark fishing at Kurrachee, province of Scinde, British India (to which Dr. Gill has kindly called my attention), Dr. Buist in 1850 wrote:

" The great basking shark or mhor, is always harpooned; it is found floating or asleep near the surface of the water; it is then stuck with a harpoon of the size and form indicated in the annexed woodcut.

" The fish, once struck, is allowed to run till tired; it is then pulled in, and beaten with clubs till stunned. A large hook is now hooked into its eyes or nostrils, or wherever it can be got most easily attached, and by this the shark

is towed on shore; several boats are requisite for towing. The mhor is often 40, sometimes 60 feet in length; the mouth is occasionally 4 feet wide."

The fins of the sharks are exported from Bombay to China.

The specimen on the Cape fortunately fell into the hands of Dr. Andrew Smith, Surgeon to the Forces, then resident at Cape Town, who records that "the specimen described was the only one that had been seen at the Cape within the memory of any of the fishermen. At the time is was discovered it was swimming leisurely near the surface of the water, with a certain portion of the back above it. When approached it manifested no great degree of fear and it was not before a harpoon was lodged in its body that it altered its course and quickened its pace."

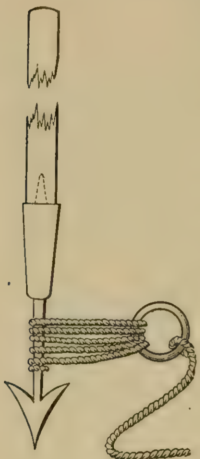


FIG. 17.—Harpoon used in capture of shark at Kurrachee.

Dr. Smith first described the animal in the *Zoölogical Journal* in 1829, where he gave what I believe to be the first notice and description of this interesting species. The title of his article is "Contributions to the Natural History of South Africa, etc.," and contains in addition to *Rhinodon*, misspelled *Rhincodon*, descriptions of new species of mammals and reptiles. I quote verbatim the original description:

"Fam. SQUALIDÆ. Genus RHINCODON Mihi.

"Dentes graciles breves leniter curvati, ordinibus longitudinalibus ita dispositi ut lineae in anteriore maxillae, nec non et mandibulae parte jacentis, speciem habeant; caput latum, depressum, quadrangulare, os ad apicem capitis cui latitudine ferè par est; latera liris longitudinalibus et carina perquam distincta in utroque caudae latere; spiraculum a tergo utriusque oculi; pinna analis alteri pinnae dorsalis pæne opposita.

"Rhincodon typus, mihi.

"Supra viridi-griseus maculis et lineis albis numerosis; subtus rubroalbus ad rubrum transiens; dorso ante anteriorem suam pinnam carinato, post rotundato, deinde plano.

"Colour of back and sides greenish gray, with numerous white spots, varying in size from that of a sixpence to a halfpenny; also several white lines on the sides of the head, body and about the branchiae; below reddish white, passing into vermillion red, anterior part of back carinated, posterior rounded or flat. Length of the specimen from which the description was taken, fifteen feet; greatest circumference, nine feet. Was caught by fishermen in Table Bay, during the month of April, 1828, and the skin was purchased for £6 sterling, and forwarded to the Paris Museum."

There followed considerable confusion in the name of Dr. Smith's new genus. He evidently first intended to use the name *Rhineodon*

RHINODON TYPICUS. PLATE 26 OF SMITH'S ILLUSTRATIONS OF SOUTH AFRICAN ZOOLOGY

and the name as printed, *Rhincodon*, was probably a mistake of the printer, so that we deem it best to now use the name finally adopted by Dr. Smith in his illustrations of the Zoology of South Africa, wherein a figure of the species is given, plate 26, published in March, 1845, and a description published in the following October. In his account of the distribution of vertebrate animals, C. L. Bonaparte in 1832 listed the name *Rhincodon* (p. 121). Muller and Henle in 1838 used the name *Rincodon*, and in the same year (1838–1839) William Swainson refers to this fish under the name *Rineodon*, (I, p. 142), *Rhineodon*, (II, p. 191), and *Rhiniodon* (II, p. 317). Swainson seemed to be under the impression that at least two different sharks were in question, or else he was careless in the construction of his artificial keys. In two places he refers to the small spiracles (II, pp. 191, 317), while in another key he says "spiracles wanting" (II, p. 314). In their valuable work entitled "Systematische Beschreibung der Plagiostomen," pp. 77 to 78, Berlin, 1841, Muller and Henle used the name *Rhinodon typicus*.

The year in which Dr. Smith founded this genus *Rhinodon* (misspelled *Rhincodon*) has all along been erroneously given as 1841—see the nomenclators—instead of 1829; the correct date being entirely overlooked by authors. We shall endeavor, in the bibliography appended to this paper, to give ready references to the literature and thus save future students much loss of time and avoid as far as possible chance for confusion in adding to the history of this shark.

Thirty years after the capture of the Cape of Good Hope specimen of *Rhinodon* the Smithsonian Institution received from Captain Stone a dental plate and other parts of the same shark, taken in the Gulf of California. On account of the erroneous descriptions of the teeth by Smith, and figure of the same by Muller and Henle, Dr. Gill was misled and described the California example as a new genus and species (*Micristodus punctatus*), properly referring it to the family *Rhinodontidæ*. Dr. Gill's notice and description of this specimen was published in the *Proceedings of the Academy of Natural Sciences*, Philadelphia, 1865, p. 177, and reads as follows:

"ON A NEW GENERIC TYPE OF SHARKS.

BY THEODORE GILL.

"In the year 1858 the Smithsonian Institution received, from Capt. Stone, the jaws and vertebræ of an enormous species of shark existing in the Gulf of California and known to the inhabitants of the neighboring regions as the 'Tiburon ballenas,' or 'whale shark.' The specimen represented by the spoils was said to have been 'twenty feet long,' with a 'head six feet wide,' 'pectorals three feet long' and 'flukes six feet between tips.' 'The back from

the head to first dorsal fin, brown with reddish spots.' The head is represented as truncated in front.

"The dried dentigerous band of the upper jaw is slightly curved forwards, about nineteen inches between the extremities, and somewhat more than an inch in width in front. The teeth are fixed and extremely minute, the largest being little more than a line in length, and decrease towards the ends of the jaw; they are disposed in regularly transverse rows, of which there are over one hundred and sixty (164–167) on each side, while in front there are from thirteen to sixteen in each transverse row; each tooth is recurved backwards and acutely pointed, swollen and with a heel-like projection in front rising from its base.

"This type will be seen, therefore, to be very distinct, but is evidently related to the South African genus *Rhinodon,* and must be referred to the family of *Rhinodontidæ* with the name of *Micristodus punctatus.*"

In 1868, Dr. Percival Wright, on a visit to Mr. Swinburn Ward, Civil Commissioner of the Seychelles, met with this shark, which is not rare in this archipelago. Dr. Wright saw specimens exceeding fifty feet in length and one actually measured by Mr. Ward was more than forty-five feet long. It is not at all rare around the Seychelles, but is seldom recorded owing to its huge size and difficulties attending its capture. In 1878 a specimen was captured at Callao, Peru. Prof. W. Nation examined this specimen and a portion of the dental plate was sent to the British Museum. In 1883 this shark was obtained on the west coast of Ceylon, the specimen being a female, 23 ft. 9 in. long. This was reported upon by Mr. A. Haly, Director of the Colombo Museum. We next quote from the voyage of the Italian Corvette, Vettor Pisani, by G. Chierchia:

"While fishing for a big shark in the Gulf of Panama during the stay of our ship in Taboga Island, one day in February (1883?), with a dead calm, we saw several great sharks some miles from our anchorage. In a short time several boats with natives went to sea, accompanied by two of the Vettor Pisani's boats.

"Having wounded one of these animals in the lateral part of the belly, we held him with lines fixed to the spears; he then began to describe a very narrow curve, and irritated by the cries of the people that were in the boats, ran off with a moderate velocity. To the first boat, which held the lines just mentioned, the other boats were fastened, and it was a rather strange emotion to feel ourselves towed by the monster for more than three hours with a velocity that proved to be two miles per hour. One of the boats was filled with water. At last the animal was tired by the great loss of blood, and the boats assembled to haul in the lines and tow the shark on shore.

"With much difficulty the nine boats towed the animal alongside the Vettor Pisani to have him hoisted on board, but it was impossible on account of his colossal dimensions. But, as it was high water, we went towards a sand beach with the animal, and we had him safely stranded at night.

"With much care were inspected the mouth, the nostrils, the ears, and all

the body, but no parasite was found. The eyes were taken out and prepared for histological study. The set of teeth was all covered by a membrane that surrounded internally the lips; the teeth are very little and almost in a rudimental state. The mouth, instead of opening in the inferior part of the head, as in common sharks, was at the extremity of the head; the jaws having the same bend.

"Cutting the animal on one side of the backbone we met (1) a compact layer of white fat 20 centimetres deep; (2) the cartilaginous ribs covered with blood vessels; (3) a stratum of flabby, stringy, white muscle, 60 centimetres high, apparently in adipose degeneracy; (4) the stomach.

"By each side of the backbone he had three chamferings or flutings, that were distinguished by inflected interstices. The color of the back was brown with yellow spots that became close and small toward the head, so as to be like marble spots. The length of the shark was 8.90 m. from the mouth to the pinna caudalis extremity, the greatest circumference 6.50 m., and 2.50 m. the main diameter (the outline of the two projections is made for giving other dimensions).

"The natives call the species tintoreva, and the most aged of the village had only once before fished such an animal, but smaller. While the animal was on board we saw several *Remora* about a foot long drop from his mouth; it was proved that these fish lived fixed to the palate, and one of them was pulled off and kept in the zoological collection of the ship."

In February, 1889, a rhinodon 22 ft. in length was cast ashore at Madras, and in April, 1890, another specimen 14 ft. 6 in. in length was caught off Bambalapitiya, Ceylon. These were reported upon by Edgar Thurston, Sup't. of the Madras Government Museum, in his very interesting paper, published in Bulletin No. 1, pp. 36 to 38, 1894, of that Museum.

Under date of July 22, 1901, Kamakichi Kishinouye, of the Imperial Fisheries Bureau, Tokyo, Japan, reported the capture of this shark in Japanese waters, and described it as a new species (*R. pentalineatus*). With Dr. Gill the writer believes the Japanese fish to be identical with *R. typicus*. The following are Mr. Kishinouye's very interesting notes upon the fish in question:

"5. A RARE SHARK, RHINODON PENTALINEATUS n. sp.

"By Kamakichi Kishinouye, Imperial Fisheries Bureau, Tokyo.

"(With 2 figs.)

"eingeg. 22. August 1901.

"On 10th of June 1901 a rare and gigantic shark was caught by drift net off Cape Inubo. Mr. Tsuratame Oseko who keeps a collection of rare things for show in Asakusa Park, Tokyo, bought the fish and brought its skin to Tokyo to be stuffed, notwithstanding many difficulties, accompanying its enormous size and ponderous weight. The external part is complete, except the portion between the anal fin and the caudal.

"The general appearance of the fish is very ugly, with the flat and blunt head, straight, terminal mouth and the small eyes. The skin is fine-grained,

except five longitudinal smooth bands one dorsal median and two pairs lateral. The ventral lateral band seems to be continuous to the keel on each side of the tail (fig. 1).

"The eyes very small, situated at the sides of the head near the margin of the colored portion of the head. The nictitating membrane wanting. The spiracles are nearly the same in size and are on the same level, with the eyes. The nostrils are at the anterior extremity of the head. They open at the labial boundary of the mouth.

"The mouth is nearly straight and opens at the anterior extremity of the head too. A labial fold from the nostril to the corner of the mouth on the upper jaw and a shorter fold from the corner of the mouth on the lower jaw (fig. 2).

"The teeth are very minute and numerous. They are nearly equal in size and shape. Each tooth is acutely pointed, laterally compressed and with an ellipsoidal root. The band of teeth on the upper jaw is curved a little and at each end of the band there is a detached group of teeth. The band on the lower jaw is crescent shaped. In each band the teeth are arranged in a great many transverse rows, about 300 in number. In the middle part of the band we count 16–30 teeth in one row.

"The gill openings are five in number and are very wide. The second pair is widest and measures 86 cm. The last pair is most narrow, it opens above the base of the pectoral fins, where the body is very broad and high. The pectoral fins are large and strong. The first dorsal fin is inserted a little behind the middle of the body. The second dorsal fin is very small. The ventral fins are inserted below the first dorsal. The clasper is simple with a dorsal groove. The anal fin is very small. It is just below the second dorsal. The caudal fin is large and lunate. Its ventral lobe is well developed.

"The color is greyish brown with white round spots and transverse bands, but the ventral side is colorless. The white round spots are small and crowded near the anterior end of the body but become gradually larger and fewer backwards. The caudal fin, the second dorsal the ventrals and the anal are destitute of white markings.

"The stuffed animal now measures 800 cm in length and 365 cm in circumference, behind the pectorals. Mr. Oseko tells me that the skin has shrunk much and that the fish measured nearly 1000 cm when fresh. He says, moreover, that the shark was covered with many sucking fishes and one of these fishes and a pole made of oak (ca. 30 cm long) were found in the stomach.

"Though the hitherto-known allied species (*Rhinodon typicus* Smith and *Micristodus punctatus* Gill) are described insufficiently, I am inclined to be-

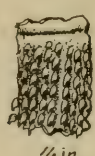


FIG. 18.—Section of dental plate.

FIG. 19.—Teeth of *Rhinodon typicus* as represented by Muller and Henle.

lieve that this fish is a new species of the Genus *Rhinodon*, as it differs from these species in the form of teeth and the labial fold. Hence I propose the name of *Rhinodon pentalineatus* for this species.

"Tokyo, 22 July, 1901."

(Zoologischer Anzeiger, Leipzig, 25 November 1901, pp. 694–695, figs. 2.)

The recorded range of this shark was much enlarged by the stranding of an 18 ft. specimen on the beach 3 miles north of Ormond, Florida, January 25, 1902, this being the first record of the occurrence of the genus on the Atlantic coast of America. The National Museum was fortunate in obtaining a good skin of this animal; a notice of its capture was published in Science, February 28, 1902.

Dr. Max Weber, in his account of the Siboga Expedition, 1899 to 1900, published in January, 1902, refers on page 88 to the presence of what he believed to be examples of *R. typicus* between the islands of Buton and Muna, Celebes. Unsuccessful efforts were made to capture one of these sharks, much to the regret of the scientists aboard.

The following measurements were obtained by the writer from the skin of the animal stranded on the Florida coast: Total length, 18 ft. Length to root of caudal, 14 ft., 6 in. Length of maxilla, 21 in. Mandible, 20 in. Width between nostrils, 21 in. Eye, $\frac{3}{4}$ in. Spiracle, $1\frac{1}{2}$ in. (doubtful measurement). Gill slits measure in inches as follows: 18, 20, 19, 16 and 13. The distance from the first to the fifth gill opening is about 15 in. The third gill opening is slightly in advance of the pectoral, the fourth and fifth slits being over the anterior portion of the pectoral. Width of base of pectoral, $18\frac{1}{2}$ in. Length of pectoral, 37 in. Length of first dorsal base, 17 in. The second dorsal fin measures as follows: Base 7 in.; height of front margin 11 in.; top margin $8\frac{1}{2}$ in.; hind margin 7 in. The ventral base $9\frac{1}{2}$ in.;

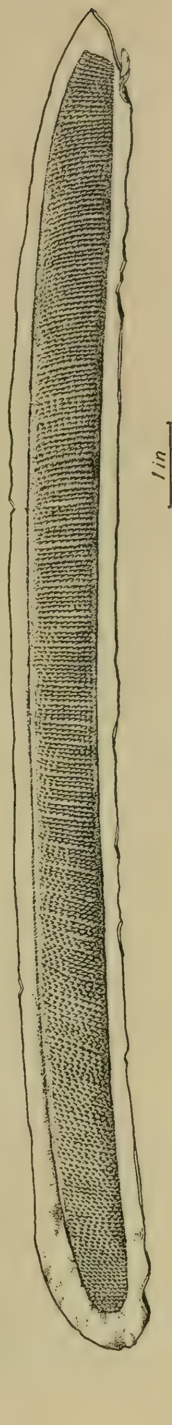


FIG. 20.—Dental plate of upper jaw of Florida specimen.

front margin 10 in.; lower margin 10 in. The anal base 6½ in.; front margin 10 in.; hind margin 7 in.; lower margin 9 in.

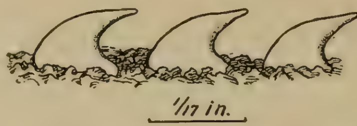


FIG. 21.—Teeth of Florida specimen enlarged.

Teeth in lower jaw in fourteen longitudinal rows; in upper jaw there are thirteen longitudinal and about three hundred vertical rows of developed teeth.

The lower dental plate is more tapering than the upper; the plate of Doctor Gill's type of *Micristodus punctatus*, preserved in the U. S. National Museum, has the teeth in fourteen horizontal and about three hundred and thirty-eight vertical rows. The accompanying photograph of these teeth, by Mr. T. W. Smillie, gives an accurate idea of their form.

The example stranded on the Florida coast was dark brownish gray, the carinated longitudinal lines chocolate colored; paler underneath; head profusely spotted with light dots, which also were present on the body though fewer and larger. No trace of the vertical light-colored transverse bands shown in Dr. Smith's illustration, and mentioned by Mr. Kishinouye, present in this specimen, which is number 50,227 of the U. S. National Museum, and preserved as a dried skin.

BIBLIOGRAPHY

Smith, Andrew.

1829 Contributions to the Natural History of South Africa. Zool. Jour., No. XVI, pp. 443–444, Jan.–May, 1829, London.

Smith, Andrew.

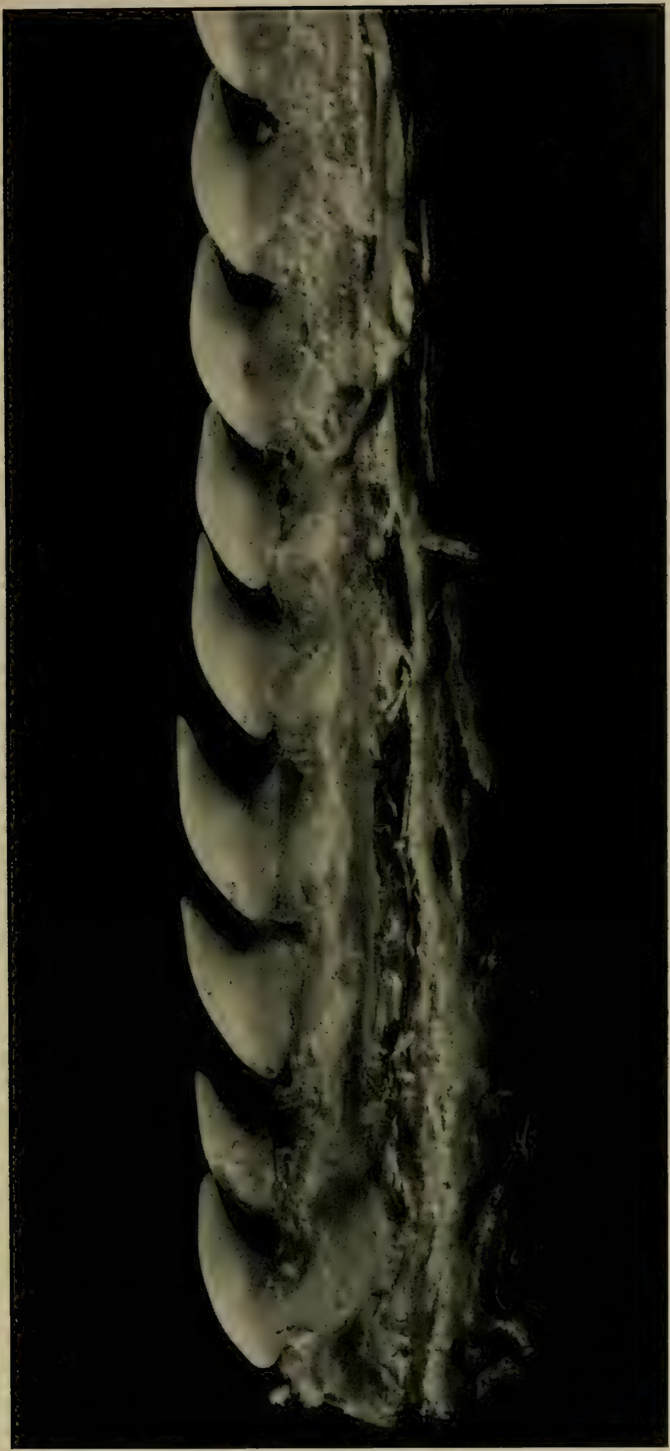
1845 Illustrations of the Zool. of South Africa. No. XXIII, pl. 26, London, 1845.

Bonaparte, C. L.

1831 Saggio di una Distribuzione Metodica Degli Animali Vertebrati, p. 121, Rome, 1831 (1832). (Giornale Arcadico di Scienze, etc., Vol. 52.)

Bonaparte, C. L.

1838 Selachorum Tabula Analytica, p. 10, 1838.



PHOTOGRAPH OF VERTICAL ROW OF TEETH FROM DENTAL PLATE OF "MICRISTODUS PUNCTATUS" GILL

(Twelve times enlarged.)

Muller and Henle.
1838 On the Generic Characters of Cartilaginous Fishes, with Descriptions of New Genera. Mag. Nat. Hist., Vol. 2, new series, p. 37, London, 1838.

Muller and Henle.
1841 Systematische Beschreibung der Plagiostomen, pp. 77–78, Berlin, 1841.

Swainson, William.
1838-39 On the Natural History and Classification of Fishes (etc.). Lardner's Cabinet Cyclopædia, Vol. 1, p. 142, Vol. 2, pp. 191, 314, 317. London, 1838–1839.

Buist, Dr.
1850 On Shark Fishing at Kurrachee. Proc. Zool. Soc. London, Part 18, 1850, pp. 100–102.

Gray, John Edward.
1851 List of Specimens of Fish in the Collection of the British Museum (Chondropterygii). Part 1, pp. 66–67. London, 1851.

Duméril, Aug.
1865 Hist. Nat. Poissons, 1, Elasmobranches, Plagiostomes, etc., pp. 428–429, Paris, 1865.

Gill, Theodore.
1865 On a New Generic Type of Sharks. Proc. Acad. Nat. Sci. Phila., p. 177, 1865.

Gill, Theodore.
The Whale Shark (Rhinodon typicus) as an American Fish. Science, N. S., Vol. xv, No. 386, pp. 824–826, May 23, 1902.

Gunther, Albert C. L. G.
1870 Cat. Fishes in Brit. Mus., VIII, p. 396, London, 1870.

Gunther, Albert C. L. G.
1880 An Introduction to the Study of Fishes. Edinburgh, 1880, p. 323.

Gunther, Albert.
1884 Voyage of the "Vettor Pisani." Nature, Aug. 14, 1884, pp. 365–366.

Wright, E. Percival.
1870 Notice of the occurrence of Rhinodon about the Seychelles. Specilogia Biologica, Dublin, 1870. Animal Life, 1879.

Lutken, Christian.
1873 Oversigt over det K. Denske Videns. Selskab Forhandlinger, 1873, pp. 47–66. See basking shark, *Selachus maximus.*

Haly, A.
On the occurrence of Rhinodon on the west coast of Ceylon. Ann. and Mag. Nat. Hist., 5th Series, XII, pp. 48–49.

Chierchia, G.
1884 The Voyage of the Vetter Pisani. Nature, London, XXX, 1884, p. 365.

Thurston, Edgar.
1894 Inspection of the Pearl Fisheries of Ceylon. Bulletin No. 1 of the Madras Museum, 1894, pp. 36–38, pl. III.

Jordan and Evermann.

1896 Fishes of North and Middle America. Bull. 47, U. S. Nat. Mus., p. 52, 1896. (*Micristodus punctatus* Gill.)

Kishinouye, Kamakichi.

1901 A rare shark, *Rhinodon pentalineatus* n. sp. Zool. Anzeiger, XXIV, 1901, pp. 694–695.

Weber, Max.

1902 The Siboga Expedition, Livr. III, Leiden, 1902, p. 88. Observations on large sharks and rays in the Celebes.

Bean, Barton A.

1902 A Rare Whale Shark. Science, N. S., Vol. XV, No. 374, p. 353, Feb. 28, 1902.

Bridge, T. W.

1904 The Cambridge Nat. Hist., Vol. 7, pp. 287, 454, London, 1904.

THE AVIAN GENUS BLEDA BONAPARTE AND SOME OF ITS ALLIES

By HARRY C. OBERHOLSER

The group of Pycnonotidae called *Bleda,* or until recently *Xenocichla,* has long been known as a very heterogeneous assemblage. No satisfactory arrangement of this genus has yet been published, nor indeed do scarcely any two authors agree concerning the proper limits of the group. It is evident on even the most superficial examination that *Bleda,* constituted for instance as it is in Dr. Sharpe's recent work,[1] contains species of several very different types of structure, which are sufficiently well characterized to warrant generic segregation. Most assuredly they are quite as different as the reasonably and almost universally recognized genera *Ixonotus, Phyllastrephus, Chlorocichla, Andropadus, Alophoixus,* and even *Trichophorus* (*Criniger* Auct.), so that if the current components of *Bleda* are to be considered congeneric, there is no good reason for not merging all the above mentioned genera into one great group, which shall include *Bleda* also. There is, in fact, no middle ground here, and if any criterion is to be set for generic subdivision, that criterion should be adhered to with at least measurable consistency. There is no difficulty in defining the groups recognized in the present revision unless they are connected by species not examined by the author, which from the descriptions of such seems not to be the case.

Very naturally the proper division and arrangement of *Bleda* has involved other closely related genera, and in order that their relationships might be best shown, these groups have been included in the succeeding exposition.

The principal measurements of which use is hereinafter made have been taken as follows:

Wing.—The distance from the bend of the wing to the tip of longest primary, taken with dividers without straightening the quills.

Tail.—The distance from the coccygeal insertion of the middle feathers to the tip of the longest rectrix.

Exposed culmen (*length of bill*).—The chord of the culmen, taken from its tip to the point where the feathers of the forehead impinge on its base.

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[1] *Hand-List Gen. and Spec. Birds,* III, 1901, pp. 320–323.

Tarsus.—Measured from the center of the heel joint behind to the edge of the last tarsal scute in front.

This paper is based about equally on the collection of the United States National Museum and that of the Academy of Natural Sciences of Philadelphia, and the writer would here express his consequent obligations to the authorities of these institutions.

TRICHOPHORUS Temminck

Tricophorus (err. typ.) TEMMINCK, Pl. Col. III, livr. 15, 1821, pl. 88 (type *Trichophorus barbatus* Temminck).

Trichophorus TEMMINCK, Pl. Col. III, livr. 15, 1821, pl. 88 (type *Trichophorus barbatus* Temminck).

Criniger TEMMINCK, Pl. Col. III, livr. 15, 1821, pl. 88, footnote (type *Trichophorus barbatus* Temminck).

Trichas GLOGER, Froriep's Notizen, XVI, 1827, p. 278 (type *Trichophorus barbatus* Temminck).

Hypotrichas HEINE, Journ. f. Ornith., 1860, p. 138 (type *Trichophorus calurus* Cassin).

Chars. gen.—Similar to *Bleda*, but head conspicuously crested; throat feathers lengthened; nuchal hairs long, not branched; bill not higher than broad at base, its height at base more than one-third of exposed culmen, the culmen curved from base, the gonys not strongly ascending.

Description.—Tail shorter than wing, but usually not less than five-sixths of it; throat feathers lengthened; tarsus scutellate; wing 4¼ to about 5½ times the length of the tarsus; tarsus not shorter than exposed culmen, sometimes 1⅓ times as long; head distinctly crested; nuchal hairs long (25 mm. or more), not branched; rictal bristles long, reaching at least about half way to end of bill; bill stout, rather short, somewhat compressed, higher than broad at anterior edge of nostrils, but at base equal in height and breadth, or broader than high; height of bill at base more than one-third the length of exposed culmen; culmen curved from base; gonys only slightly ascending; maxillar tomium with only one subterminal notch; nostrils rounded oval, slightly or not at all operculate anteriorly, but distinctly, sometimes broadly so posteriorly; frontal feathering not extending beyond posterior edge of nostrils;[1] bristles of nostrils long and rather numerous.

Type.—*Trichophorus barbatus* TEMMINCK.

This genus as here restricted differs from all its allies below

[1] This means that no feathers *grow* above or below the nostrils, although those inserted behind sometimes project over or beyond the posterior portion of the open nares.

treated in the possession of a well-marked crest, and from the various individual genera in also other respects which will be evident in the following diagnoses.

The name *Criniger,* by which this group has been usually designated, is untenable, and should be replaced by *Trichophorus.* It will readily be seen, on examination of the original description of *Criniger*[1] that the characters there given might with equal propriety apply to any of several African genera of Pycnonotidae; no particular species is mentioned in connection with the name; and it is said to be founded on five *undescribed* species from western Africa![2] In fact *Criniger* is here a *nomen nudum,* and is identifiable only by Temminck's later statement in his larger work where he proposes *Trichophorus* for the same birds and explicitly repudiates *Criniger.*[3] In this place, after giving a detailed diagnosis of his genus *Trichophorus* he makes the following observation: " Ce genre a été indiqué dans l'Analyse du système, voyez *Manuel d'Ornithologie,* page LX"; to which he adds the following footnote: "(1) Le genre 12e de la page citée renferme d'analyse du genre *Crinon,* que nous avions nommé en latin *Criniger.* Cette dénomination ayant été jugée vicieuse, nous proposons celle de *Trichophorus,* pour nom scientifique du genre." In view of this, there seems to be no way to avoid the rejection of *Criniger* and the acceptance of *Trichophorus.* The former, moreover, should date from the same place, but only as a synonym of *Trichophorus.* A word might also be said regarding the proper spelling of *Trichophorus.* Where the term first appears, as a heading to the generic diagnosis,[5] it is spelled *Tricophorus,* but in the above quoted footnote on the same page, as well as in the succeeding description of *Trichophorus barbatus,* it is written *Trichophorus,* which fact seems to furnish ample justification for regarding the form "*Tricophorus*" as a typographical error, and for consequently accepting the proper spelling *Trichophorus.*

The removal of several East Indian forms which are clearly not congeneric leaves this genus a fairly homogeneous one, and admits of a satisfactory diagnosis. Some of the African species have rather

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[1] Temminck, *Man. Orn.,* I, 1820, p. lx.

[2] "Formé de cinq espèces nouvelles qui n'ont point de type parmi celles connues; toutes sont de côtes occidentales d'Afrique; plusieurs ont un bouquet de crins à la nuque." *Idem, Ibid.,* pp. lx–lxi.

[3] Pl. Col. III, livr. 15, 1821, pl. 88.

[4] Pl. Col. III, livr. 15, 1821, pl. 88.

[5] *Ibid.*

broader bills with a more extended nasal operculum, and vary some in other proportions, but the differences do not seem sufficiently marked to render advisable at present a further subdivision of the group.

Of the species now to be referred to this genus, one, *Trichophorus gularis* (Horsfield),[1] requires to be renamed, since its present title is preoccupied by *Turdus gularis* Latham[2] which is *Cinclus merula* (SCHÄFFER) (= *aquaticus* AUCT.); and it may be known as *Trichophorus xanthizurus*.

A list of the species of this genus follows:

Trichophorus chloronotus Cassin.
Trichophorus calurus Cassin.
Trichophorus verreauxi verreauxi (Sharpe).
Trichophorus verreauxi ndussumensis (*Reichenow*).
Trichophorus flaveolus Gould.
Trichophorus frater (Sharpe).
Trichophorus burmanicus (Oates).
Trichophorus griseiceps (Hume).
Trichophorus salangae (Sharpe).
Trichophorus xanthizurus Oberholser (= *gularis* Horsfield, nec Latham).
Trichophorus tephrogenys Jardine and Selby (= *gutturalis* Bonaparte).
Trichophorus sordidus (Richmond).
Trichophorus henrici (Oustalet).
Trichophorus pallidus (Swinhoe).
Trichophorus ruficrissus (Sharpe).
Trichophorus sumatranus (Wardlaw-Ramsay).
Trichophorus barbatus Temminck.
Trichophorus conradi (Finsch).
Trichophorus finschi (Salvadori).
Trichophorus palawanensis (Tweeddale).

ALOPHOIXUS Oates.

Alophoixus OATES, Fauna Brit. India, Birds, I, 1889, p. 259.

Chars. gen.—Similar to *Trichophorus*, but differing chiefly in having no occipital crest, and a much less evident nasal operculum.

Description.—Tail about five-sixths of wing; throat feathers lengthened; tarsus scutellate; wing about 4½ times the length of the tarsus; tarsus 1⅛ to 1¼ times the length of exposed culmen; head not crested; nuchal hairs long (25 mm. or more), not branched; rictal bristles reaching at least half way to end of bill; bill stout, rather short, moderately compressed, higher than broad at anterior edge of nostrils, slightly broader than high at base, its height at base more than one-third the length of exposed culmen; culmen curved

[1] *Turdus gularis* Horsfield, *Trans. Linn. Soc. Lond.*, XIII, 1821, p. 150.
[2] *Turdus gularis* Latham, *Suppl. Ind. Orn.*, 1801, p. xl.

from base; gonys slightly ascending; maxillar tomium with but one subterminal notch; nostrils much rounded, scarcely operculate, and if at all, only posteriorly; frontal feathering not extending beyond posterior edge of nostrils; bristles of nostrils long and rather numerous.

Type.—*Ixos phaeocephalus* HARTLAUB.

This is a small group apparently well entitled to generic rank, though in most respects very similar to *Trichophorus,* with which of course it has closest affinity. Its long, unbranched nuchal hairs and lengthened throat feathers will serve readily to distinguish it from other allied genera which have rounded nostrils.

The only species of this group are:

Alophoixus phaeocephalus (Hartlaub).
Alophoixus diardi (Finsch).

IDIOCICHLA[1] gen. nov.

Chars. gen.—Similar to *Bleda,* but bill much shorter, its height at base decidedly more than one-third of exposed culmen; culmen not straight; tarsus at least 1¼ times exposed culmen.

Description.—Tail about nine-tenths of wing; throat feathers not lengthened; tarsus scutellate; wing about 4 times the length of tarsus; tarsus 1⅓ to 1½ times exposed culmen; head not crested; nuchal hairs short (less than 20 mm.), much branched; rictal bristles strong, reaching at least two-thirds the length of the bill; bill stout, rather short, compressed, much higher than broad at anterior edge of nostrils, about equal in height and breadth at base, its height at base more than one-third of exposed culmen; culmen somewhat curved; gonys decidedly ascending; mixillar tomium with but one subterminal notch; nostrils rounded oval, only slightly operculate, and that posteriorly; forehead feathered to posterior edge of nostrils; nasal bristles long and numerous.

Type.—*Trichophorus notatus* CASSIN.

This group is most closely allied to *Bleda,* and scarcely needs comparison with other genera unless possibly with *Thescelocichla, Alophoixus,* and *Trichophorus,* for all the others with superficial resemblance have linear or lengthened nostrils.

The species are:

Idiocichla notata (Cassin).
Idiocichla canicapilla (Hartlaub).

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[1] ἴδιος, distinctus; κίχλη, turdus.

[2] *Postea,* p. 154.

BLEDA Bonaparte

Bleda BONAPARTE, Rev. et Mag. Zool., Feb., 1857, p. 50 (type, *Dasycephala syndactyla* Swainson).
Xenocichla HARTLAUB, Orn. Westafr., 1857, p. 86 (type, *Dasycephala syndactyla* Swainson).

Chars. gen.—Resembling *Alophoixus,* but throat feathers not lengthened; nuchal hairs short (less than 20 mm.), much branched: tarsus about equal to exposed culmen; height of bill at base not more than one-third of exposed culmen; gonys strongly ascending; bill longer and more compressed, the culmen straight except at decurved tip; nasal operculum more evident.

Description.—Tail about nine-tenths of wing; throat feathers not lengthened; tarsus scutellate; wing about 4½ times the tarsus; exposed culmen and tarsus about equal; head not crested; nuchal hairs short (less than 20 mm.), much branched; rictal bristles long, reaching about half way to end of bill; bill large and stout, decidedly compressed, higher than broad at base and at anterior edge of nostrils, the height at base about equal to one-third of exposed culmen, but sometimes less; culmen straight, except of course at decurved tip; gonys strongly ascending, the angle conspicuous; maxilla with but one subterminal notch; nostrils rounded oval, somewhat operculate, chiefly posteriorly; frontal feathering not extending beyond hinder edge of nostrils; nasal bristles long and rather numerous.

Type.—*Dasycephala syndactyla* SWAINSON.

As here constituted, this is a fairly well defined group, and by reason of the structure of the nostrils much more nearly related to *Trichophorus, Alophoixus, Idiocichla,* and *Thescelocichla* than to several other groups that have, like the two latter, often, if not usually, been considered congeneric.

The species here included in this genus are:

Bleda syndactyla (Swainson).
Bleda eximia (Hartlaub).
Bleda xavieri (Oustalet).
Bleda multicolor (Bocage).

THESCELOCICHLA[1] gen. nov.

Chars. gen.—Similar to *Bleda,* but rictal bristles weak; bill shorter, not so stout, its height less than its breadth at base, but more than one-third of exposed culmen; culmen curved at least on distal two-thirds; gonys almost horizontal; tarsus about 1⅓ times exposed culmen.

[1] *θέσκελος*, mirabilis; *κίχλη*, turdus.

Description.—Tail about nine-tenths of wing; throat feathers not lengthened; tarsus rather lightly scutellate; wing about 4¼ times the tarsus; tarsus about 1⅓ times exposed culmen; head not crested; nuchal hairs short (less than 20 mm.), branched; rictal bristles weak, reaching only about one-third the length of the bill, not extending beyond the anterior edge of nostrils; bill rather strong, moderately lengthened, somewhat compressed, higher than broad at anterior edge of nostrils, but broader than high at base, its height at base more than one-third of exposed culmen; culmen curved almost from base; gonys only slightly ascending; maxillar tomium with but one subterminal notch; nostrils rounded oval, a very little or not at all operculate, posteriorly; frontal feathering not extending beyond posterior margin of nostrils; bristles of nostrils few and short.

Type.—*Phyllastrephus leucopleurus* CASSIN.

This genus is so different from *Bleda* (*syndactyla*) that it seems rather remarkably to have escaped separation until now. Of its other allies possessing roundish nostrils it needs further comparison with only *Idiocichla,* from which, however, it is easily distinguished.

Apparently the only species belonging here is:

Thescelocichla leucopleura (Cassin).

ATIMASTILLAS[1] gen. nov.

Chars. gen.—Resembling *Bleda,* but nostrils lengthened; rictal bristles weak; height of bill at base much more than one-third of exposed culmen; culmen curved from base; gonys but slightly ascending, the angle not conspicuous; tarsus much longer than culmen; bristles of nostrils few and short.

Description.—Tail about equal to wing or slightly less; throat feathers not lengthened; tarsus scutellate; wing about 4⅓ times the tarsus; tarsus about 1⅜ times the exposed culmen; head not crested; nuchal hairs short, branched; rictal bristles weak, reaching not more than one-third the length of bill, and not beyond anterior edge of nostrils; bill stout, rather short, somewhat compressed, higher than broad at anterior edge of nostrils, about equal in height and breadth at base, its height at base nearly one-half the exposed culmen; culmen much curved from base; gonys only a little ascending; maxilla with but one subterminal notch; nostrils lengthened oval, operculate; frontal feathering not extending beyond posterior edge of nostrils; nasal bristles very few and short.

[1] *ἀτίμαστος*, neglectus; *ἰλλάς*, turdus.

Type.—Haematornis flavicollis SWAINSON.

This genus is superficially close to *Thescelocichla,* but aside from the lengthened, conspicuously operculate nostrils, by which it may be readily distinguished, it has a somewhat shorter tail, and a much more arched bill.

The four forms here referred to this genus are apparently only subspecifically distinct:

Atimastillas flavicollis flavicollis (Swainson).
Atimastillas flavicollis shelleyi (Neumann).
Atimastillas flavicollis pallidigula (Sharpe).
Atimastillas flavicollis flavigula (Cabanis).

PROSPHOROCICHLA[1] nom. nov.

Pyrrhurus CASSIN, Proc. Acad. Nat. Sci. Phila., 1859, p. 46 (type *Phyllastrephus scandens* Swainson) (nec *Pyrrhura* Bonaparte).

Chars. gen.—Similar to *Bleda,* but nostrils lengthened, conspicuously operculate; rictal and nasal bristles weaker; culmen curved from base; gonys only slightly ascending; bill shorter, somewhat depressed, its height less than its breadth at base, its height at base more than one-third the exposed culmen; tarsus about 1½ times the length of exposed culmen.

Description.—Tail about nine-tenths of wing, or slightly more; throat feathers not lengthened; tarsus scutellate; wing 4 to 4¼ times the tarsus; tarsus 1½ to 1¾ times the exposed culmen; head not crested; nuchal hairs rather long, much branched; rictal bristles rather weak, not reaching half the length of the bill; bill of moderate length, somewhat depressed, higher than broad at anterior edge of nostrils, broader than high at base, the height at base more than one-third the exposed culmen; culmen curved almost from base; gonys but slightly ascending; maxilla with but one subterminal notch; nostrils lengthened oval, operculate throughout; frontal feathering not extending beyond posterior edge of nostrils; nasal bristles few and rather short.

Type.—Phyllastrephus scandens SWAINSON.

Captain Shelley has united *Ptyrticus* Hartlaub with the present group,[2] but an examination of even the description and figures of *Ptyrticus*[3] seems quite sufficient to indicate that it is very different; furthermore, it apparently does not belong in the same *family!*

This genus was long ago named *Pyrrhurus* by Cassin,[4] but

[1] πρόσφορος, similis; κίχλη, turdus.
[2] *Ibis,* 1899, p. 373.
[3] Hartlaub, *Zool. Jahrb.,* II, 1887, p. 314, pl. XI, fig. I.
[4] *Proc. Acad. Nat. Sci. Phila.,* 1859, p. 46.

Pyrrhurus is preoccupied by *Pyrrhura* Bonaparte[1] given to a group of Psittacidæ; and, as there are no synonyms, it has been renamed as above.

An examination of the specimens of *Prosphorocichla scandens* from the Ogobai, or Ogowe, River, Gabun, recorded by Cassin as *Pyrrhurus pallescens*,[2] and still in the Academy of Natural Sciences of Philadelphia, has developed the fact that they are very different from true *scandens* of Senegal. Since *Trichophorus pallescens* Hartlaub[3] is based on specimens from Gambia, and is identical with *scandens*, the Gabun bird is apparently without a name. Through the courtesy of Mr. Witmer Stone it is here described, and called:

PROSPHOROCICHLA SCANDENS ACEDIS subsp. nov.

Chars. subsp.—Similar to *Prosphorocichla scandens scandens*, but decidedly smaller; entire upper parts, with sides of head, darker, the lores barely paler than the crown, and together with the back and scapulars, less ochraceous (more grayish), the rump less tawny; superior wing-coverts and outer vanes of primaries much more grayish (less rufescent), barely different from the back; under wing-coverts darker, more grayish; lower parts, excepting the crissum, grayish white without buff or cream color, except for a faint tinge on the middle of lower breast and abdomen.

Description.—Type, adult, sex unknown, No. 17,028, collection Academy Nat. Sci. Phila.; Ogobai River, Gabun, western Africa, 1858; P. Du Chaillu. Head brownish slate, lighter on forehead; back and scapulars grayish brown; rump more rufescent; upper tail-coverts and tail tawny, the shafts paler; wing-quills and their superior coverts grayish brown, scarcely more rufescent than the back, the exterior margins of most of the outer primaries a little paler; lores and sides of head and neck brownish slate gray about like the forehead but rather more brownish; lower parts dull white, shaded with gray across the breast and with brownish gray on the sides and flanks, the center of abdomen and lower breast slightly washed with yellowish; crissum buff; under wing-coverts olive gray mixed with yellowish.

From *Prosphorocichla scandens orientalis*[4] this new form differs

[1] Bonaparte, *Naumannia*, 1856, p. 352 (table); Souancé, *Rev. et Mag. Zool.*, 1857, p. 97; Bonaparte, *Compt. Rend.*, XLIV, 1857, p. 538.

[2] *Proc. Acad. Nat. Sci. Phila.*, 1859, p. 46.

[3] *Orn. Westafr.*, 1857, p. 86.

[4] *Xenocichla orientalis* Hartlaub, *Journ. f. Ornith.*, 1883, p. 425 (Tamaja, British Equatorial Africa).

in larger size; much darker top and sides of head; darker sides of neck; and less yellowish lower surface.

Comparative measurements of the three forms are as follows:

Name.	Locality.	Wing.	Tail.	Exposed Culmen.	Tarsus.	Middle Toe.
Prosphorocichla scandens scandens.	Senegal.	118	109	15.5[3]	27.5	18
Prosphorocichla scandens acedis.[1]	Ogobai River, Gabun.	96	88	15.5	23	16
Prosphorocichla scandens acedis.	Ogobai River, Gabun.	100	96	15.5	25	16.5
Prosphorocichla scandens orientalis.[2]	Tamaja, British Equatorial Africa.	93	80	15	22	—

This genus apparently comprises only the following:

Prosphorocichla scandens scandens (Swainson) (=*pallescens* Hartlaub).
Prosphorocichla scandens acedis Oberholser.
Prosphorocichla scandens orientalis (Hartlaub).

BAEOPOGON Heine

Baeopogon HEINE, Journ. f. Ornith., 1860, p. 139.

Chars. gen.—Somewhat resembling *Bleda,* but tail very much shorter; nostrils linear, operculate; bill shorter, much depressed, broader than high at base, the culmen curved almost throughout, the gonys but slightly ascending; rictal and nasal bristles much shorter; tarsus relatively longer.

Description.—Tail about three-fourths of wing; throat feathers not lengthened; tarsus strongly scutellate; wing nearly 5 times the tarsus; tarsus 1¼ times the culmen; head not crested; hairs on nape short, much compound; rictal bristles reaching about one-third the length of the bill, not beyond the anterior margin of nostrils; bill rather short and stout, decidedly depressed, much broader than high both at base and anterior edge of nostrils, its height at base about equal to one-third the length of exposed culmen; culmen moderately curved almost or quite from base; gonys but slightly ascending; maxillar tomium with only one subterminal notch; nostrils linear, strongly operculate, the frontal feathering not extending beyond their posterior margin; nasal vibrissae few and short.

Type.—*Criniger indicator* VERREAUX.

This very distinct genus may easily be distinguished from all its

[1] Type.
[2] Measurements from original description, *loc. cit.*
[3] Imperfect.

allies by its much abbreviated tail, as well as by various other excellent characters.

The species are:

Baeopogon indicator (Verreaux) (= *batesi* Sharpe).
Baeopogon clamans (Sjöstedt).

IXONOTUS Verreaux

Ixonotus VERREAUX, Rev. et Mag. Zool., 1851, p. 306.

Chars. gen.—Similar to *Prosphorocichla,* but nuchal hairs shorter, not branched; tarsus relatively shorter; bill shorter, equal in height and breadth at anterior edge of nostrils, its height at base about equal to one-third the length of exposed culmen.

Description.—Tail about nine-tenths of wing; throat feathers not lengthened; tarsus scutellate; wing about 4¼ times the tarsus; tarsus about 1⅜ times the exposed culmen; head not crested; nuchal hairs very short, not branched; rictal bristles not reaching half the length of the bill—but little beyond anterior edge of nostrils; bill rather short, somewhat depressed, with height and breadth about equal at anterior edge of nostrils, the height less than the breadth at base, the height at base about equal to one-third the exposed culmen; culmen curved from base; gonys only slightly ascending; maxilla with only one subterminal notch; nostrils almost linear, operculate, the frontal feathering extending only to their posterior margin; nasal bristles few and short.

Type.—*Ixonotus guttatus* VERREAUX.

This genus is apparently most closely allied to *Prosphorocichla,* from which it differs as above stated, but these characters are by no means as great as those separating *Prosphorocichla* from *Bleda;* and *Ixonotus,* so many and decided are its differences, hardly needs comparison with *Bleda* as here restricted.

The two species of this group are:

Ixonotus guttatus Verreaux.
Ixonotus landanae Oustalet.

PHYLLASTREPHUS Swainson

Phyllastrephus SWAINSON, Fauna Bor. Amer., II, 1831, p. 486 (type Le Jaboteur, Levaillant).

Phyllostrophus SUNDEVALL, Av. Disp. Tentamen, 1872, p. 20 (nom. emend. pro *Phyllastrephus*).

Chars. gen.—Similar to *Ixonotus,* but bill longer, more slender, somewhat compressed, higher than broad at anterior edge of nostrils, the culmen almost straight except at tip; nostrils more oval; nuchal hairs much branched.

Description.—Tail less than wing, but usually at least nine-tenths of it; throat feathers not lengthened; tarsus scutellate; wing 3½ to 4½ times the tarsus; tarsus 1⅓ to 1½ times the culmen; head not crested; nuchal hairs short, much branched; rictal bristles rather weak, not reaching beyond the middle of the bill; bill rather long and slender, somewhat compressed, higher than broad at anterior edge of nostrils, approximately equal in height and breadth at base, the height at base about equal to one-third the length of exposed culmen; culmen almost straight except at tip; gonys nearly straight—only slightly ascending; maxillar tomium with but one subterminal notch; nostrils lengthened oval, operculate, the frontal feathering not extending to their posterior margin; nasal bristles few and short.

Type.—*Phyllastrephus terrestris* SWAINSON.

The rather long, slender bill, and straight culmen, in combination with various other characters, render this genus easily distinguishable from all its allies.

The following species appear to be referable to this group, though a few of them are somewhat aberrant:

Phyllastrephus terrestris terrestris Swainson (= *capensis* Swainson).[1]
Phyllastrephus terrestris suahelicus (Reichenow).
Phyllastrephus strepitans strepitans (Reichenow) (= *sharpei* Shelley).
Phyllastrephus strepitans rufescens (Hartlaub) (= *pauper* Sharpe, et *parvus* Fischer and Reichenow).
Phyllastrephus cerviniventris Shelley.
Phyllastrephus fulviventris Cabanis.
Phyllastrephus simplex (Hartlaub) (= *harterti* Reichenow, et *marchei* Oustalet).
Phyllastrephus placidus (Shelley).
Phyllastrephus poensis Alexander.
Phyllastrephus cabanisi cabanisi (Sharpe).
Phyllastrephus cabanisi sucosus (Reichenow).
Phyllastrephus baumanni Reichenow.
Phyllastrephus flavostriatus (Sharpe) (= *tenuirostris* Fischer and Reichenow).
Phyllastrephus alfredi (Shelley).
Phyllastrephus debilis (W. Sclater).
Phyllastrephus fischeri (Reichenow).
Phyllastrephus kretschmeri Reichenow and Naumann.

ARGALEOCICHLA[2] gen. nov.

Chars. gen.—Similar to *Phyllastrephus*, but bill more depressed, much broader than high at base, about equal in height and breadth at anterior edge of nostrils, the height at base much less than one-

[1] *Cf.* Richmond, *Auk*, 1900, p. 179.
[2] ἀργαλέος, difficilis; κίχλη, turdus.

third the length of exposed culmen; nostrils more lengthened; tarsus less than 1¼ times the length of exposed culmen; nuchal hairs less branched; rictal and nasal bristles decidedly longer.

Description.—Tail about nine-tenths of wing; throat feathers not lengthened; tarsus scutellate; wing about 4 times the tarsus; tarsus 1⅛ times the exposed culmen; head not crested; nuchal hairs short (less than 20 mm.), slightly branched; rictal bristles long, reaching about two-thirds the length of the bill; bill long, rather slender, depressed, equal in height and breadth at anterior edge of nostrils, much broader than high at base, its height at the latter point much less than one-third the length of exposed culmen; culmen, except at tip, straight or even slightly concave; gonys somewhat ascending; maxilla with one subterminal notch; nostrils linear, operculate, the frontal feathering extending only to their posterior margin; bristles of nostrils long and rather numerous.

Type.—*Trichophorus icterinus* BONAPARTE.

The present more careful examination has convinced us that we were wrong in considering the type of this genus congeneric with *Bleda syndactyla.*[1] It is in reality very distinct, differing from *Bleda* in its linear nostrils; less branched nuchal hairs; relatively longer rictal bristles; more slender, depressed bill, with less sharply ascending gonys; and longer tarsus, as compared with length of culmen. The generic separation of this species from *Criniger ictericus* Strickland will doubtless do away with all objection to the use of its earliest and therefore correct specific name *icterina.*

Some doubt exists regarding the reference of *Xenocichla poliocephala* Reichenow to this genus, as the species has not been available for examination. It certainly does not belong in *Bleda,* nor do its characters, in so far as they have been expressed in published diagnoses, seem to fit any other genus so well as *Argaleocichla.* It is even possible that a new genus will be necessary for its reception.

The only species that appear to belong under this heading are:

Argaleocichla icterina (Bonaparte) (= tricolor Cassin).
Argaleocichla poliocephala (Reichenow).

THAPSINILLAS[2] gen. nov.

Chars. gen.—Similar to *Trichophorus,* but head not crested; throat feathers not lengthened; nuchal hairs short; nostrils linear, operculate; tarsus much shorter than culmen, and more than 5½ times con-

[1] *Proc. U. S. Nat. Mus.,* XXII, 1899, p. 14.
[2] θάψινος, flavus; ἰλλάς, turdus.

tained in the length of wing; bill longer and relatively more slender, the culmen almost straight; rictal bristles much weaker.

Description.—Tail about nine-tenths of wing; throat feathers not lengthened; tarsus slightly scutellate; wing about 5¾ to 6 times the length of tarsus; tarsus only about five-sixths of exposed culmen; head not crested; nuchal hairs short, not branched; rictal bristles rather weak, reaching about one-third the length of bill, and scarcely beyond the nostrils; bill lengthened, somewhat compressed, higher than broad at anterior edge of nostrils; not quite so high as broad at base, the height at base about equal to one-third the exposed culmen; culmen only slightly curved—almost straight except at tip; gonys distinctly ascending; maxillar tomium with but one subterminal notch; nostrils more or less linear, much operculate, the frontal feathering not extending beyond their posterior edge; nasal vibrissæ long and moderately numerous.

Type.—*Criniger affinis* HOMBRON and JACQUINOT.

The species of this genus, though heretofore included in *Trichophorus,* are really very different in structural details from the typical members of the latter, and indeed are much more closely allied to *Phyllastrephus, Argaleocichla,* and several other African groups. From all the related genera with lengthened nostrils *Thapsinillas* may easily be distinguished, however, by its very short tarsus, this being considerably less than the exposed culmen.

The following species belong here:

Thapsinillas affinis (Jacquinot and Pucheran).
Thapsinillas mystacalis (Wallace).
Thapsinillas longirostris (Wallace).
Thapsinillas platenae (W. Blasius).
Thapsinillas aurea (Walden).

ACRITILLAS[1] gen. nov.

Chars. gen.—Somewhat similar to *Bleda,* but nostrils linear, operculate; nuchal hairs not appreciably branched; bill much shorter, more slender, depressed, the culmen curved from base, the gonys nearly or quite horizontal; tarsus decidedly longer than culmen.

Description.—Tail a little more than nine-tenths of wing; throat feathers not lengthened; tarsus at least slightly scutellate; wing 4¼ to 4¾ times the tarsus; tarsus 1⅛ times the exposed culmen; head not crested; hairs on occiput and nape short, not branched; rictal bristles reaching from one-third to one-half the length of the bill; bill rather slender, somewhat depressed, higher than broad at anterior

[1] ἄκριτος, confusus; ἰλλάς, turdus.

edge of nostrils, broader than high at base, its height at the latter point about equal to one-third of the exposed culmen; culmen curved from base; gonys straight or very nearly so; maxilla with but one subterminal notch; nostrils linear, strongly operculate, the frontal feathering extending not beyond their posterior margin; bristles of nostrils rather few and of moderate length.

Type.—*Criniger ictericus* STRICKLAND.

In many of its characters this genus is far removed from *Bleda,* and is indeed much nearer even *Thapsinillas.* Its points of difference from all neighboring groups may be easily seen by consulting the diagnoses given.

Apparently the only species referable here are:

Acritillas icterica (Strickland).
Acritillas chloris (Finsch).
Acritillas lucasi (Hartert).

ARIZELOCICHLA[1] gen. nov.

Chars. gen.—In some respects resembling *Bleda,* but nostrils linear, strongly operculate, the basal half of the operculum more or less feathered; bill much shorter, more turdine, depressed at base, its height at this point decidedly more than one-third the length of exposed culmen; culmen curved from base; gonys almost horizontal; tarsus very much longer than exposed culmen.

Description.—Tail about nine-tenths of wing, or somewhat more; throat feathers not lengthened; tarsus scutellate; wing 3¾ to 4¼ times the tarsus; tarsus 1⅖ to 1⅗ times the exposed culmen; head not crested; nuchal hairs short, much branched; rictal bristles reaching about half way to end of bill; bill moderately slender, very thrush-like, somewhat depressed, higher than broad at anterior edge of nostrils, decidedly broader than high at base, its height at base more than one-third the length of exposed culmen; culmen curved nearly or quite from base; gonys only slightly ascending; maxilla with but one subterminal notch; nostrils linear, much operculate, the frontal feathering extending more or less continuously above them to about the middle of the operculum; nasal bristles few and rather short.

Type.—*Xenocichla nigriceps* SHELLEY.

Excellent evidence of the hitherto unsatisfactory generic position of the type and several other species of this group is the manner in which various authors have treated them, placing them first in one genus, then in another, with scarcely any uniformity or agreement. Least of all the genera to which they have been at times referred

[1] ἀρίζηλος, evidens; κίχλη, turdus.

do they belong in *Bleda;* but find apparently their nearest ally in *Chlorocichla,* from which, however, they may be readily distinguished.

The species are:

Arizelocichla nigriceps (Shelley).
Arizelocichla olivacea (Swainson).
Arizelocichla albigularis (Sharpe) (= *leucolaema* Sharpe).
Arizelocichla fusciceps (Shelley).
Arizelocichla falkensteini (Reichenow).
Arizelocichla chlorigula (Reichenow) (= *chlorolaema* Sharpe).
Arizelocichla striifacies (Reichenow and Neumann).
Arizelocichla kikuyuensis (Sharpe).
Arizelocichla milanjensis (Shelley).
Arizelocichla kakamejae (Sharpe).
Arizelocichla tephrolaema (Gray).

CHLOROCICHLA Sharpe

Chlorocichla SHARPE, Cat. Birds Brit. Mus., VI, 1881, p. 112.

Chars. gen.—Similar to *Arizelocichla,* but tail about equal to wing; nuchal hairs rather shorter; bill stouter, more compressed, and relatively shorter, the frontal feathering extending farther out on nasal operculum.

Description.—Tail equal to wing, or very slightly shorter; throat feathers not lengthened; tarsus strongly scutellate; wing about 3¾ times the length of tarsus; tarsus about 1½ times the exposed culmen; head not crested; hairs on nucha short, branched; rictal bristles rather weak, reaching about half way to end of bill; bill moderately short, somewhat stout and compressed, higher than broad at anterior edge of nostrils, broader than high at base, the height at base, however, more than one-third the length of exposed culmen; culmen curved from base; gonys slightly ascending; maxilla with one subterminal notch; nostrils almost linear, operculate, the basal three-fourths of the operculum more or less feathered; nasal bristles few and short.

Type.—*Trichophorus flaviventris* SMITH.

This excellent genus is very different from both *Bleda* and *Phyllastrephus,* under each of which it has at times been placed. All its forms appear to be subspecies of a single species.

They are:

Chlorocichla flaviventris flaviventris (Smith).
Chlorocichla flaviventris mombasae (Shelley).
Chlorocichla flaviventris centralis (Reichenow).
Chlorocichla flaviventris zambesiae (Shelley).
Chlorocichla flaviventris occidentalis (Sharpe).

STELGIDILLAS Oberholser

Stelgidillas OBERHOLSER, Proc. U. S. Nat. Mus., XXII, 1899, p. 30.

Chars. gen.—Similar to *Arizelocichla,* but maxilla with several (3 to 4) subterminal notches; bill proportionately longer and more slender, its height at base less than one-third the length of exposed culmen, the culmen nearly straight except at tip; rictal bristles much shorter; nuchal hairs not noticeably branched.

Description.—Tail slightly more than nine-tenths of wing, but not equal to wing; throat feathers not lengthened; tarsus rather lightly scutellate; wing about 4 times the length of tarsus; tarsus about 1¼ times the exposed culmen; head not crested; nuchal hairs short, not appreciably branched; rictal bristles short and weak, reaching but little beyond the anterior edge of nostrils; bill rather long and comparatively slender, depressed, equal in height and breadth at anterior edge of nostrils, broader than high at base, the height at the latter point less than one-third the length of exposed culmen; culmen only slightly curved—nearly straight, except at tip; gonys almost horizontal, though a little ascending; maxillar tomium with several (3 to 4) subterminal notches, of which the distal one is the most pronounced; nostrils almost linear, much operculate, the operculum feathered, though rather sparsely, on its basal half; nasal bristles few and rather short.

Type.—*Andropadus gracilirostris* STRICKLAND.

This peculiar genus forms the first transition step from the long billed forms with a single subterminal maxillar notch, to the short billed ones with a serrate maxilla. The unbranched nuchal hairs show some relationship with *Trichophorus,* while the much lengthened nostrils indicate its affinity with such groups as *Arizelocichla, Acritillas,* and *Argaleocichla.*

There seems to be but a single species referable here, which with its several subspecies, is as follows:

Stelgidillas gracilirostris gracilirostris (Strickland).
Stelgidillas gracilirostris liberiensis (Reichenow).
Stelgidillas gracilirostris poensis (Alexander).
Stelgidillas gracilirostris percivali (Neumann).

CALYPTOCICHLA[1] nom. nov.

Trichites HEINE, Journ. f. Ornith., 1860, p. 139 (type *Criniger serinus* Verreaux) (nec Lycett 1850).

Chars. gen.—Similar to *Stelgidillas,* but nasal operculum densely feathered quite to anterior margin; bill relatively shorter, higher

[1] καλυπτός, coöpertus; κίχλη, turdus.

than broad at anterior edge of nostrils, its height at base about equal to one-third the length of exposed culmen; culmen much more curved; rictal bristles weaker.

Description.—Tail about nine-tenths of wing; throat feathers not lengthened; tarsus scutellate; wing about 4 times the length of tarsus; tarsus about 1⅕ times the exposed culmen; head not crested; nuchal hairs short, not branched; rictal bristles weak, reaching less than one-fourth the length of bill, and not beyond the anterior edge of nostrils; bill rather slender, depressed basally, higher than broad at anterior margin of nostrils, decidedly broader than high at base, its height at base equal to one-third of exposed culmen; culmen much curved; gonys practically horizontal; maxillar tomium with several subterminal notches; nostrils linear, slit-like, strongly operculate, the operculum densely feathered throughout; nasal bristles short and very few in number.

Type.—*Criniger serinus* VERREAUX.

This genus is notable for its closely and completely feathered nasal operculum, in which respect it is differentiated from all its allies. It seems undoubtedly to be most nearly related to *Stelgidillas,* but is in many respects intermediate between the latter and *Andropadus.* With other genera, already treated, it scarcely needs comparison.

The name *Trichites,* long ago given to this group by Heine,[1] is preoccupied by *Trichites* Lycett,[2] for a fossil mollusk, and has therefore been replaced by the name above used.

The type is the only species, and should stand as:

Calyptocichla serina (Verreaux).

ANDROPADUS Swainson

Andropadus SWAINSON, Fauna Bor.-Amer., II, 1831, p. 485 (type L'importun, Levaillant).

Polyodon LAFRESNAYE, Mag. Zool., 1832, Cl. II, pl. 4 (type *Turdus importunus* Vieillot).

Chars. gen.—Similar to *Calyptocichla,* but bill relatively shorter, stouter, decidedly compressed, its height at base more than one-third the length of exposed culmen; tarsus at least 1½ times the exposed culmen; nostrils wider; nasal operculum feathered on only its basal half, and much less densely; rictal bristles longer; nuchal hairs branched.

Description.—Tail less than wing, but more than nine-tenths its length; throat feathers not lengthened; tarsus strongly scutellate;

[1] *Journ. f. Ornith.,* 1860, p. 139.

[2] *Ann. and Mag. Nat. Hist.,* Ser. 2, v, 1850, p. 343.

wing about 4 times the tarsus; tarsus 1½ to 1¾ times the exposed culmen; head not crested; nuchal hairs short, branched; rictal bristles rather short and weak, reaching less than half the length of the bill; bill short, stout, compressed, much higher than broad at anterior edge of nostrils, equal in height and breadth at base, its height at latter point more than one-third of exposed culmen; culmen ridged, curved from base; gonys a little ascending; maxilla with several subterminal notches or tooth-like serrations on its cutting edge; nostrils almost linear, much operculate, the basal half of operculum more or less feathered; nasal bristles few and short, reaching scarcely beyond the anterior margin of nostrils.

Type.—Turdus importunus VIEILLOT.

The presence of serrations on the distal portion of the cutting edge of the maxilla in this and several allied genera is a good character, though by no means the sole means by which these groups may be separated from *Arizelocichla* and its near relatives, for even without it they can be excellently diagnosed. Captain Shelley,[1] however, claims that this character is worthless, since an occasional specimen is found that does not possess the serrations; but it seems quite unnecessary to reject this as a means of diagnosis simply because in a very few immature or aberrant individuals it does not appear. Such a principle generally applied might seriously endanger some very good and widely recognized genera! In the particular cases now under consideration, moreover, the serrations on the maxillar tomium are so conspicuous, so nearly always present, and so entirely absent in all the other genera of this paper, that there seems to be more than ample reason for their conspicuous employment in diagnoses.

Some of the recently described forms of this group have not been available for examination, but they seem to be correctly placed. Assuming this to be so, this genus consists of the following:

Andropadus importunus (Vieillot).
Andropadus masukuensis Shelley.
Andropadus curvirostris curvirostris Cassin (= *cameronensis* Reichenow).
Andropadus curvirostris alexandri (Oustalet).
Andropadus insularis insularis Hartlaub (= *flavescens* Hartlaub; *oleaginus* Peters).
Andropadus insularis subalaris Reichenow.
Andropadus insularis somaliensis Reichenow.
Andropadus laetissimus Sharpe.

[1] *Ibis*, 1899, p. 372.

CHARITILLAS[1] gen. nov.

Chars. gen.—Similar to *Stelgidillas,* but bill much shorter, the height at base more than one-third the exposed culmen, the culmen ridged and curved from base; tarsus relatively shorter; frontal feathering not extending beyond posterior edge of nostrils; nuchal hairs much shorter; rictal and nasal bristles longer.

Description.—Tail nine-tenths of wing; throat feathers not lengthened; tarsus scutellate; wing 4¾ times the length of tarsus; tarsus about 1½ times the exposed culmen; head not crested; nuchal hairs very short—scarcely noticeable, little if any branched; rictal bristles reaching half the length of bill; bill short, moderately slender, somewhat compressed, higher than broad at anterior edge of nostrils, about equal in height and breadth at base, its height at the latter point more than one-third the length of exposed culmen; culmen much ridged, curved from base; gonys only very slightly ascending; maxillar tomium with several (4 to 5) conspicuous subterminal notches; nostrils much lengthened, almost linear, strongly operculate; the operculum bare of feathers, but the nostrils partially covered by the nasal bristles and antrorse frontal plumes; nasal bristles long and rather numerous.

Type.—*Andropadus gracilis* CABANIS.

The type and apparently sole species of this genus was hesitantly placed by the writer in *Stelgidillas,*[2] and the present examination shows that it certainly does not belong there; Dr. Sharpe has recently removed it to *Eurillas*[3] where it is still more out of place. From the latter genus *Charitillas* differs decidedly in its much lengthened, strongly operculate nostrils; much more slender and compressed bill, with more distinctly ridged culmen; relatively shorter tarsus; shorter nuchal hairs; and somewhat weaker rictal bristles.

The only species is:

Charitillas gracilis (Cabanis) (= *minor* Bocage).

STELGIDOCICHLA[4] gen. nov.

Chars. gen.—Similar to *Eurillas,* but bill longer, relatively more narrow, its height at base equal to one-third the length of exposed culmen; culmen more ridged, and straight, or even slightly concave, except of course at tip; nostrils not quite so much rounded; nasal

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[1] χάρις, gratia; ἰλλας, turdus.

[2] *Proc. U. S. Nat. Mus.,* XXII, 1899, pp. 30–31.

[3] *Ibis,* 1904, p. 635.

[4] στελγίς, strigilis; κίχλη, turdus.

operculum feathered for nearly its basal half; lateral feathers of throat much lengthened; and tarsus relatively longer.

Description.—Tail less than wing, but more than nine-tenths of it; middle throat feathers not lengthened, lateral ones much longer, forming on each side a conspicuous moustache; tarsus but lightly scutellate, sometimes almost imperceptibly; wing 3¾ times the tarsus; tarsus about 1⅗ times the exposed culmen; head not crested; nuchal hairs short, branched; rictal bristles long, reaching about two-thirds the length of the bill; bill rather short, broad, much depressed, wider than high at anterior edge of nostrils, and much so at base, its height at base equal to one-third the length of exposed culmen; culmen much ridged, straight or slightly concave, except at decurved tip; gonys slightly ascending; cutting edge of maxilla with several subterminal notches; nostrils oval, slightly operculate; basal portion of operculum rather sparsely feathered to about the middle of nostril; nasal bristles long and rather numerous.

Type.—*Andropadus latirostris* STRICKLAND.

Although superficially close to *Eurillas* this group really differs very considerably, as above detailed; while by reason of its serrate maxilla, broad bill, and roundish nostrils it scarcely needs comparison with other genera.

Its forms are:

Stelgidocichla latirostris latirostris (Strickland).
Stelgidocichla latirostris eugenia (Reichenow).
Stelgidocichla latirostris congener (Reichenow).
Stelgidocichla latirostris efulensis (Sharpe).

EURILLAS Oberholser

Eurillas OBERHOLSER, Proc. U. S. Nat. Mus., XXII, 1899, p. 15.

Chars. gen.—Somewhat similar to *Andropadus*, but nostrils rounded oval, little operculate; bill shorter, broader, much depressed, the culmen less ridged; rictal and nasal bristles decidedly longer; tail relatively somewhat shorter.

Description.—Tail about nine-tenths of wing; throat feathers not lengthened; tarsus scutellate; wing about 4 times the tarsus; tarsus about 1½ times the exposed culmen; head not crested; nuchal hairs short, branched; rictal bristles long, reaching to between one-half and two-thirds the length of the bill; bill short, broad, much depressed, wider than high at anterior edge of nostrils, much so at base, where its height is barely more than half its width, the height at base, however, more than one-third the length of exposed culmen; culmen not much ridged, at least appreciably curved from base,

sometimes decidedly so; gonys slightly ascending; maxillar tomium with several notches on its distal portion; nostrils rounded oval, a little operculate basally, not at all anteriorly, the frontal feathering not extending beyond the posterior margin of nostrils; nasal bristles long and rather numerous.

Type.—*Andropadus virens* CASSIN.

The roundish nostrils at once separate this very distinct genus from all its relatives with serrate maxilla, excepting *Stelgidocichla,* and from this it may easily be distinguished by other characters, as above shown.

The species are:

Eurillas virens virens (Cassin).
Eurillas virens grisescens (Reichenow).
Eurillas virens zombensis (Shelley) (= *marwitzi* Reichenow).
Eurillas montana (Reichenow).

Following is a key to the genera treated in the present connection:

A.—Maxillar tomium with two or more subterminal notches.
  a.—Nostrils roundish oval and but little operculate.
    b.—Bill shorter and broader, its height at base decidedly more than one-third the length of exposed culmen; frontal feathering not extending beyond posterior edge of nostrils; lateral feathers of throat not lengthened............................*Eurillas*
    b'.—Bill longer and more narrow, its height at base about equal to one-third the length of exposed culmen; frontal feathering extending superiorly to middle of nostrils; lateral feathers of throat conspicuously lengthened................*Stelgidocichla*
  a'.—Nostrils linear or lengthened oval, much operculate.
    b.—Narial operculum densely feathered to anterior edge of nostril ....*Calyptocichla*
    b'.—Narial operculum sparsely feathered, and not much, if any, beyond middle of nostril.
      c.—Exposed culmen long, almost straight except at tip; height of bill at base less than one-third its length, the height and breadth equal at anterior edge of nostrils..*Stelgidillas*
      c'.—Exposed culmen short, curved throughout; height of bill at base more than one-third its length, its height at anterior edge of nostril greater than its breadth at same point.
        d.—Frontal feathering extending on operculum nearly to middle of nostril; rictal and narial bristles shorter and weaker; bill much stouter, more compressed. *Andropadus*
        d'.—Frontal feathering not extending beyond posterior edge of nostril; rictal and narial bristles longer and stronger; bill more slender, less compressed. *Charitillas*

B.—Maxillar tomium with but one subterminal notch.

a.—Nostrils rounded oval.

b.—Nuchal hairs long (25 mm. or more) and not branched; throat feathers lengthened.

c.—Head not conspicuously crested; nasal operculum barely perceptible .... *Alophoixus*

c′.—Head conspicuously crested; nasal operculum evident, at least posteriorly.............................. *Trichophorus*

b′.—Nuchal hairs short (less than 20 mm.) and much branched; throat feathers not lengthened.

c.—Tarsus about equal to exposed culmen; height of bill at base not more than one-third the length of exposed culmen. *Bleda*

c′.—Tarsus at least one and one-fourth times the length of exposed culmen; height of bill at base more than one-third the length of exposed culmen.

d.—Rictal bristles weak, not reaching beyond anterior edge of nostrils; narial vibrissae few and weak; bill longer, less compressed, its height at base decidedly less than its breadth............................ *Thescelocichla*

d′.—Rictal bristles strong, about two-thirds the length of bill, reaching far beyond the anterior edge of nostrils; narial vibrissae long and numerous; bill shorter, more compressed, its height and breadth at base about equal .... *Idiocichla*

a′.—Nostrils linear or lengthened oval.

b.—Tarsus shorter than exposed culmen; wing more than five times the length of the tarsus......................... *Thapsinillas*

b′.—Tarsus longer than exposed culmen; wing less than five times the length of the tarsus.

c.—Height of bill at base more than one-third the length of exposed culmen.

d.—Nostrils linear or nearly so; frontal feathering extending on operculum at least to middle of nostril; rictal bristles reaching to about middle of bill.

e.—Tail about equal to wing; bill stout, somewhat compressed .... *Chlorocichla*

e′.—Tail shorter than wing; bill rather slender, somewhat depressed..................... *Arizelocichla*

d′.—Nostrils lengthened oval; frontal feathering not extending beyond posterior edge of nostrils; rictal bristles not reaching to middle of bill.

e.—Bill stouter, relatively shorter, somewhat compressed, about equal in height and breadth at base; nuchal hairs shorter......................... *Atimastillas*

e′.—Bill weaker, relatively longer, depressed, its height at base decidedly less than its breadth; nuchal hairs longer...................... *Prosphorocichla*

c′.—Height of bill at base not more than one-third the length of exposed culmen.

d.—Tail shorter, about three-fourths of wing.... *Baeopogon*
d'.—Tail longer, about nine-tenths of wing, or more.
e.—Tarsus less than one and one-fourth times the length of exposed culmen.
f.—Culmen straight or slightly concave, except at decurved tip; gonys decidedly ascending; bill about equal in height and breadth at anterior edge of nostrils, its height at base much less than one-third of exposed culmen. *Argaleocichla*
f'.—Culmen curved from base; gonys almost straight; bill higher than broad at anterior edge of nostrils, its height at base about equal to one-third of exposed culmen.... *Acritillas*
e'.—Tarsus more than one and one-fourth times the length of exposed culmen.
f.—Bill shorter and relatively stouter, somewhat depressed, equal in height and breadth at anterior edge of nostrils, the culmen curved from base; nuchal hairs shorter and not branched .... *Ixonotus*
f'.—Bill longer and relatively more slender, somewhat compressed, higher than broad at anterior edge of nostrils, the culmen almost straight except at tip; nuchal hairs longer and much branched........... *Phyllastrephus*

SCAPHOCEROS TYRRELLI, AN EXTINCT RUMINANT FROM THE KLONDIKE GRAVELS

By WILFRED H. OSGOOD

While engaged in work for the U. S. Biological Survey in the summer of 1904, I spent some days in Dawson, Yukon Territory. During this time I was so fortunate as to make the acquaintance of Mr. J. B. Tyrrell, formerly of the Geological Survey of Canada, and well known for his long and difficult trips through the great Barren Grounds west of Hudson Bay. Mr. Tyrrell's interest in natural history led him to preserve certain fossils found by himself and others in the Klondike region. Among these were two imperfect skulls of supposed musk oxen which he very generously presented to me for deposit in the U. S. National Museum. One of these is extremely well preserved. The characters of practically the entire skull are well shown, the chief missing parts having been lost from one side only. The molars and premolars of the left side and the second and third molars of the right side are intact. The skull is evidently that of a very old individual, as the teeth are much worn. The bone is lightly scratched by gravel over much of its surface, but the spaces between the scratches are smooth and evidently in original condition, so it does not appear that the form and dimensions of any of the bones have been materially altered. The bone is of a dark brown color and not impregnated to any degree with mineral matter. The second specimen is much less complete, comprising only the posterior part of a skull and one attached horn core.

These specimens represent an animal evidently related to the existing genus *Ovibos,* but sufficiently different to rank as a separate genus, for which a name is here proposed. The species called *O. cavifrons* by Leidy is closely related and falls in the same genus. *O. maximus* of Richardson possibly belongs here also, but for the present can only be considered indeterminate. The genus *Boötherium,* in which *O. cavifrons* was included by Leidy, is recognized as distinct, with *Bos bombifrons* Harlan as the type.

For the privilege of describing this interesting fossil, I am indebted to Dr. C. Hart Merriam, Chief of the U. S. Biological Survey. In connection with the study, I have been greatly assisted by the loan of specimens from Dr. F. W. True, of the U. S. National Mu-

seum, Mr. Witmer Stone, of the Academy of Natural Sciences of Philadelphia, and Dr. J. A. Allen, of the American Museum of Natural History. To Mr. Stone I am particularly grateful for the loan of the valuable types of *O. cavifrons* and *B. bombifrons.* For assistance in handling specimens, thanks are due Mr. Walter L. Hahn, Aid, Division of Mammals, U. S. National Museum.

SCAPHOCEROS TYRRELLI gen. et sp. nov.

Type from 70 feet below the surface in gravels in Lovett Gulch, Bonanza Creek, Klondike District, Yukon Territory, Canada. No. 2,555, U. S. National Museum. Male, old. Received from J. B. Tyrrell.

Generic Characters.—Similar to *Ovibos,* but horn cores much smaller, less compressed at base, and more divergent at tips; crown of skull between bases of horn cores surmounted by a prominent exostosis with an anterior bounding rim and a deep median excavation; orbits much less produced laterally than in *Ovibos;* facial part of skull nearly as wide as cranial; basioccipital without a high median ridge; teeth very large and relatively broad; m^1 and m^2 quadrate in transverse view.

Specific Characters.—Size smaller than in *S. cavifrons* (Leidy); horn cores much smaller and shorter; exostosis less extensive but more deeply excavated; depth of braincase and surmounting bony mass decidedly less.

Comparison with Ovibos moschatus.—Skull longer and of more uniform width than that of *Ovibos moschatus,* the facial region not abruptly narrower than the cranial. This gives the skulls of the two genera very different outlines, particularly as viewed from above, for while *Scaphoceros* is narrower than *Ovibos* across the orbits, it is wider between the maxillaries. Anterior part of skull much elongated, although not narrowed abruptly as in *Ovibos;* maxillaries and premaxillaries much longer. The ascending branch of the premaxillary apparently does not reach the nasals but ends in nearly the same relative position as in *Ovibos* but at an angle of lesser degree, since it does not turn up so abruptly. Exposed part of frontals, not covered by exostosis, much less extensive but suture with nasals apparently in same relative position in plane of front of orbits. This exposed part of the frontals is much narrower and more elevated between the orbits, but notwithstanding this, the groove between the elevated median part and the orbits is much less pronounced and does not appear to extend to the shelf

overhanging the lacrymal fossæ. Lacrymal fossæ about the same depth as in *Ovibos* but the shelves above them, instead of being at right angles to the axis of the skull, run diagonally from the orbits to the frontals, ending on the sides of the frontals in the plane of the posterior ends of the nasals. Orbits but slightly produced and scarcely projecting beyond the zygomata, even less tubular than in *Bison,* and differing widely from the much produced form of *Ovibos.*

The posterior aspect of the skull is quite different from that of *Ovibos.* This is largely produced by a more decided constriction of the bony mass of the parietals beneath the horn cores and a more highly developed lambdoid crest. The mastoid width is therefore relatively much greater than the width immediately below the horn cores. Supraoccipital more excavated and occipital condyles more projecting; foramen magnum decidedly larger both actually and relatively; the occipital condyles much larger, wider, and more produced; basioccipital widely different, its sides not parallel nor nearly so, median line grooved instead of having a high trenchant median ridge. Auditory capsules apparently smaller; meatus larger and less deflected backwards. Posterior nares much wider and more flaring, the alisphenoid walls particularly larger and apparently somewhat arcuate instead of nearly straight in posterior outline. Palatine likewise larger and more expanded laterally, decidedly swollen just behind the plane of the last molar; sphenopalatine foramen much larger and more elliptical in shape (greatest diameter 42 mm.). Vomer much larger and more swollen. Postglenoid process strongly deflected backward instead of being nearly at a right angle to the axis of the skull. The palatal parts of the maxillaries curve gently from side to side but do not show the strong depression anteriorly that is found in *Ovibos.* The divided orifice of the parietotemporal canal is very large and placed relatively far back so that it is nearly midway between the lambdoid crest and the anterior border of the glenoid facet. Malar large and heavy though not inflated about the orbit as in *Ovibos* being merely produced into a heavy roughened ridge from which it spreads out on the face to join the maxillary. Facial part of lacrymal relatively more extensive; just below the prominent lacrymal fossa and immediately in front of the rim of the orbit is a slight depression or possible tendency to a secondary fossa. Lacrymal protuberance in the bottom of the orbit much larger than that of *Ovibos* and entirely different in shape; it is flattened below and ends posteriorly in a thin lamella on a plane with the posterior border of the sphenopalatine

foramen. The flattened lower surface of this protuberance is almost horizontal and parallel to the main axis of the skull. It is evidently an important character, differing widely, as it does, from the same structure in *Ovibos, Bos, Bison,* and *Ovis.*

Horn Cores and Exostosis.—In the type specimen which is evidently a very old male, the horn cores relative to the size of the skull and in comparison with those of adult male *Ovibos* are very slender. At their bases the antero-posterior expansion is comparatively slight. Although the vertical diameter of the horn cores is less at any point than the horizontal diameter, there is in comparison with the horn cores of *Ovibos* a decided tendency toward roundness. A cross section of the horn core near the base would be elliptical but a section taken four inches from the base would be more nearly ovoid. The direction of the cores although somewhat downward is distinctly away from the skull, and the tips are directed forward.

Between the bases of the horn cores and for some distance anterior to them is a roughened and much perforated bony growth or exostosis occupying the greater part of the crown of the skull. In *Ovibos* there is a somewhat similar growth, which, however, is all on the same plane with the top of the horn cores, is but slightly produced anteriorly, and is always divided by a deep median channel the floor of which is continuous with the normal surface of the frontals. In *Scaphoceros* this exostosis is depressed between the horns forming an oblong excavation bounded laterally by the bases of the horn cores and anteriorly by a rugose shelf-like rim which is elevated like a crown over the frontals and the base of the orbits. Posteriorly the depression is open though there are evidences that it may have been inclosed by a rim similar to the anterior one. Fully a third of the exostosis and depression is anterior to the plane of the front of the bases of the horn cores so that the anterior bounding shelf reaches almost to the plane of the front of the orbits. The anterior boundary shows no evidence of a median division, but the depression appears to have been traversed by a median ridge; in *S. cavifrons* this ridge is more plainly shown. Possibly the horny sheaths that covered the exostosis in the living animal were completely united. At least it is safe to assume that the two sides were more closely apposed than in *Ovibos,* and that the horn sheaths were shaped very differently at the base.

Teeth.—The teeth of *Scaphoceros* are actually larger than those of *Bison bison.* In size and shape they differ widely from those of *Ovibos* but in structure appear to be quite similar. Their propor-

tions, without regard to size, are very different. The entire molar and premolar series is much wider relative to its length than in *Ovibos* or *Ovis,* in this respect being like *Bison.* The width of $m\underline{1}$ is almost as great as the length and that of the much worn $m\underline{2}$ is even greater than the length, though it is possible that the unworn crowns might not show the same proportions. However, the alveolus of $m\underline{1}$ is much wider than long. The longest tooth is $m\underline{3}$, which is more than a third longer than $m\underline{2}$, whereas in *Ovibos* these teeth are nearly equal in length.

The arrangement of enamel folds seems to be much the same as in *Ovibos* but this is open to question since specimens of exactly equal stages of wear are not available for comparison. The greater width of the teeth naturally allows space for a greater proportion of dentine. With the exception of $m\underline{3}$, all the teeth seem to be less prolonged into a posterior loop. In *Ovibos* this posterior loop fits into a corresponding depression in the front of the next succeeding tooth. In *Scaphoceros,* where the posterior loop is scarcely or not at all developed, the corresponding depression is absent.

The accessory inner columns which are so well developed in *Bos* and *Bison* are not shown in the aged and worn teeth of the type of *Scaphoceros.* Since they occur in young *Ovibos,*[1] they may well be expected in *Scaphoceros* when young specimens are found.

Relationship.—In its important characters, *Scaphoceros* appears to be more closely related to *Ovibos* than to any other recent genus. In its departures from *Ovibos,* it shows possible approach to *Bison;* on the other hand there is nothing indicating any further ovine characters than those that are claimed for *Ovibos.* The bearing of this upon the much discussed question as to whether *Ovibos* is more bovine or ovine in its relationships is rather favorable to the former. Without attempting to review all the moot points of this case, it may

[1] The positive occurrence of these accessory columns in *Ovibos* has been noted by Rutimeyer (*Die Rinder der Tertiar-Epoche,* p. 91, 1867—fide Lönnberg) and later by Lönnberg (*Proc. Zool. Soc. Lond.,* p. 712, June, 1900), but seems to have attracted little attention, since the statement that they are absent in this genus is often seen. A young skull (No. $\frac{5094}{6252}$ U. S. Nat. Mus.) of *Ovibos moschatus* from Fort Good Hope, Mackenzie River, shows the accessory column plainly. In this skull $m\underline{3}$ is only partly developed, being scarcely above the alveolar border; so far as can be observed under these conditions, the accessory column is not present in this tooth. In $m\underline{2}$ which is advanced enough to have been functional, the column is well developed and conspicuous. It is a thin column occupying the single inner reentrant angle and apparently derived from the inner anterior fold of the tooth. In $m\underline{1}$ there is a trace of the same structure partly worn away, showing that continued wear would have caused it to disappear entirely.

be well to mention a few suggestive facts brought out by a study of the skull of *Scaphoceros.*

Since the accessory columns in the inner angles of the molar teeth are possessed by *Ovibos* (and probably by *Scaphoceros*) as well as *Bos* and *Bison* (see footnote, antea, p. 177) this character can only be used to separate these genera collectively from the sheep and related forms which never possess it. Without considering external characters, *Ovibos* and *Scaphoceros* may then be distinguished from *Bos* and *Bison* and their relatives by the possession of lacrymal fossæ, by the shape, direction, and manner of attachment of the horns, and by numerous less important characters. In some of these *Scaphoceros* shows more appproach to *Bison* than does *Ovibos.* Among them are the size and relative width of the teeth, the grooved basioccipital, and the more nearly round horns. These similarities, however, seem to be greatly overbalanced by the differences and do not necessarily indicate a bison-like ancestor for the musk ox. It seems more reasonable that *Ovibos* came from a more remote ancestor than *Bison* and developed along lines of its own. This has been ably set forth by Lönnberg (l. c.) and there appears to be nothing in the characters of *Scaphoceros* that would argue greatly against his views.

In connection with any supposition that *Scaphoceros* may be an ancestral form of *Ovibos,* it is interesting to note that some characters of the adult *Scaphoceros* are found in the young *Ovibos.* In the young skull previously mentioned (see footnote, antea, p. 177) the basioccipital is very similar to that of the adult *Scaphoceros,* having a median depression and sides that are not parallel; also, the orbits are less produced laterally, the occipital condyles relatively wider, and the horn cores more divergent and less compressed, all of which approaches the condition of the adult in *Scaphoceros.* A still more primitive form is *Boötherium bombifrons* which, in the adult, has round horn cores, a condition only found in very immature *Ovibos.*

History and Nomenclature.—Remains of animals related to or indistinguishable from the recent genus *Ovibos* have been found in Pleistocene gravels of various parts of the world. They were first found in Siberia near the Obi River and account of them was published by Pallas in 1773. Later, others from various parts of Siberia were unearthed and then more were found in the 'ice cliffs' of Eschscholtz Bay, Alaska. In course of time specimens came to light from the Mississippi Valley and from various parts of Europe, including England, Germany, and France. Such a large number of fragments naturally elicited a few new specific names, most of

which however, have been loosely treated as synonyms of *Ovibos moschatus.* The names applied to supposed extinct species are as follows:

1825. *Bos bombifrons* Harlan, Fauna Americana, pp. 271–272, 1825.
1827. *Ovibos pallantis* H. Smith, Griffith's Cuvier, Anim. Kingd., IV, p. 374, 1827.
1828. *Bos pallasii* Dekay, Ann. Lyc. Nat. Hist. N. Y., II, p. 291, 1828.
1834. *Bos canaliculatus* Fischer, Mem. Acad. Moscou, III, p. 287, 1834.
1852. *Ovibos cavifrons* Leidy, Proc. Acad. Nat. Sci. Phila., p. 71, 1852.
1854. *Ovibos maximus* Richardson, Zool. Voy. H. M. S. Herald, pp. 25–28, pl. XI, figs. 2–4, 1854.
1865. *Ovibos priscus* Rutimeyer, Verhandl. Naturforsch. Gesellsch. Basel, IV, p. 328, 1865.
1895. *Bison appalachicolus* Rhoads, Proc. Acad. Nat. Sci. Phila., pp. 246–248, 1895.

These various names may be treated separately as follows:

1. *Bos. bombifrons* was based on a portion of a skull with the horn cores attached found at Big Bone Lick, Kentucky, near the falls of the Ohio River. It was collected at the instance of President Jefferson by no less a person than Gen. Wm. Clark, famous with his associate Lewis for their overland expedition to the Pacific. The specimen was described and figured in 1818[1] but received no scientific name until 1825 when Harlan called it *Bos bombifrons.* Apparently its relationship with *Ovibos* was not suspected until 1852, when Leidy provisionally placed it in that genus and immediately designated it, in company with *O. cavifrons,* as belonging to a new genus, *Boötherium.* In the same year Leidy published a complete description and new figures[2] of the original specimen under the name *Boötherium bombifrons.*

Rutimeyer in 1865 (l. c.), basing his conclusions on Leidy's figures, announced the opinion that the type of *bombifrons* was the skull of a female animal, the male being the one called *cavifrons.* A few years later, Boyd Dawkins, without reference to Rutimeyer, expressed the same belief.[3] More recent authors, have therefore accepted this conclusion and placed *cavifrons* as a synonym of *bombifrons.*[4]

2. *Ovibos pallantis* was proposed for remains of parts of skulls of musk oxen found in the 18th century along the Obi River in

[1] Caspar Wistar, *Trans. Am. Philos. Soc.,* I, pp. 375–380, pl. XI, figs. 10–11, 1818.

[2] *Mem. on Extinct Species of Am. Ox,* Smiths. Cont. Knowl., V, pp. 17–19, pl. IV, fig. 2, pl. V, figs. 1–2, 1852.

[3] *Paleontog. Soc.,* vol. XXV, pt. V, p. 20, 1871.

[4] *E. g.,* Lydekker, *Wild Oxen, Sheep, and Goats of All Lands,* p. 148, 1898.

western Siberia. They were described and figured by Pallas in 1773[1] but no name was given until 1827 when Hamilton Smith proposed *Ovibos pallantis,* mentioning the specimens described by Pallas, and also certain others from the region of the Lena River previously figured by Ozeretkofsky. The figures published by Pallas indicate an animal very similar to or identical with *Ovibos moschatus.* Much reduced copies of these figures were reproduced by Cuvier.[2]

3. *Bos pallasii* was based on the same specimens as *Bos pallantis* and is therefore a synonym. It is, moreover, preoccupied by *Bos pallasii* Baer 1823, proposed for a different animal. In the same paper in which Dekay proposed the name *pallasii,* he described a specimen from New Madrid, Missouri, which evidently belongs to the species later called *cavifrons* by Leidy.

4. *Bos canaliculatus* was based on skulls found in Siberia, doubtless the same species that was named *Ovibos pallantis* by Smith, and likewise not satisfactorily distinguished from *Ovibos moschatus.* The name *canaliculatus* refers to the narrow median groove or channel between the bases of the horn cores.

5. *Ovibos cavifrons* was based on a cranium and attached horn cores from the vicinity of Fort Gibson, Indian Territory. It was included with *Bos bombifrons* in the genus *Boötherium* when that name was proposed. Later it was thought to be a synonym of *bombifrons* on the supposition that the differentiating characters were those of male and female. If this supposition is not correct, as I believe, the specific name *cavifrons* must be used for the species described by Leidy. Specimens similar in general to the type of *cavifrons* have been found in various parts of the Mississippi Valley, one particularly complete having been reported from Council Bluffs, Iowa.[4]

6. *Ovibos maximus* was based on an imperfect cervical vertebra, the axis or dentata. Whether this is actually different from the same bone in *Ovibos moschatus* has not been conclusively shown. In fact, Richardson himself admitted some doubt. Leidy, in answering certain remarks by Richardson, was quick to notice this, and in one place makes the following pointed comment: "Sir J. R. then says, 'The size of Dr. Leidy's specimen of *cavifrons* does not exceed that of the skull of an aged musk-ox bull, and the dentata of

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[1] *Novi Comment. Acad. Sci. Imp. Petrop.,* XVII, pp. 576–606, pl. XVII, figs. 1–3, 1773.

[2] *Oss. Foss. Quad.,* IV, pl. III, figs. 9–10, 1812.

[3] *Foss. Mamm. Prussia,* p. 27, 1823—fide Lydekker.

[4] McGee, *Am. Jour. Sci.,* XXXIV, pp. 217–220, 1887.

maximus is of corresponding dimensions.' If this be the case I would ask, as the '*dentata* of *maximus*' was found in the country of 'the musk-bull,' and is of the same size as the corresponding bone in that animal, what evidence is there that it does not belong to it?"[1]

The dentata described as *O. maximus* may represent the same species as the one here described as *tyrrelli,* but there seems to be no material now available by which this can be determined. At least it is certain that the dentata shows no generic characters. As it is necessary to have a species for the type of a genus, the only specimen which shows generic characters should be taken as the type of both species and genus. By so doing, the genus becomes established and will not be affected should later developments prove that the type species is a synonym.

7. *Ovibos priscus* is a substitute name for both *B. bombifrons* and *O. cavifrons,* which by some esoteric method of reasoning was supposed to be necessary, when it was assumed that *cavifrons* represented the male and *bombifrons* the female of one species.

8. *Bison appalachicolus* was based on a rather small fragment of the base of a horn. It was at first placed in the genus *Bison,* and considered as an intermediate form between *Bison* and *Ovibos.* Later it was transferred to the genus *Ovibos* by the same author.[2]

The Genus Boötherium.—Boötherium, when originally proposed by Leidy[3] included two species, *Bos bombifrons* Harlan and *Ovibos cavifrons* Leidy. Since that time neither of these has been removed as the type of a new genus. If it is now concluded that these species are not congeneric, one of them must be designated or fixed as the type of *Boötherium.* I have therefore selected *Bos bombifrons* Harlan as the type of *Boötherium* and referred *O. cavifrons* Leidy to the new genus *Scaphoceros,* of which the type is *S. tyrrelli.* As justifying this fixing of the type, it may be said that at the time *Boötherium* was proposed, *Bos bombifrons* had been thoroughly described and figured, whereas *O. cavifrons* had received only slight preliminary mention. Moreover *B. bombifrons* was the species first mentioned in the paper in which *Boötherium* was first published.

Since *bombifrons* and *cavifrons* have been considered by several authors as being not only congeneric but conspecific, the establishment of a separate genus for each may appear surprising. While it may be possible, from examination of figures only, to construct a hypothesis to the effect that *cavifrons* represents the male and *bombi-*

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[1] *Proc. Acad. Nat. Sci. Phila.,* pp. 209–210, 1854.

[2] *Proc. Acad. Nat. Sci. Phila.,* p. 492 (1897), Jan. 18, 1898.

[3] *Proc. Acad. Nat. Sci. Phila.,* p. 71, 1852.

frons the female of one species, it is inconceivable that any modern taxonomist would reach such a conclusion after comparing the original types. These are now before me and with them are specimens of *S. tyrrelli* and of both sexes and young of *Ovibos moschatus*. From comparisons of these it is evident that, unless the disparity between the sexes in this case was vastly greater than in the recent genus *Ovibos, cavifrons* and *bombifrons* do not respectively represent the male and female of one species. Neither is *bombifrons* the young of any species, for the type gives every evidence of maturity.[1]

The horn cores of the female *Ovibos* are essentially of the same character as those of the male. They are excessively flattened and directed downward close to the skull just as those of the male. Their bases approach each other over the top of the frontals increasing with age as in the male, the space between them being merely relatively greater than in the male.[2] They are attached to the frontals only it is true, but this is the case with the immature male. Therefore the skull of the female has all the essential characters of the male but they are not as highly developed. The skull of *Boötherium bombifrons,* on the contrary, differs not in degree but in actuality from that of *Scaphoceros cavifrons* and *S. tyrrelli.* The horn cores are not flattened but are actually round or as nearly round as may be in a rough surfaced structure; they are directed away from the skull at a different angle; their attachment to the skull is entirely different; their bases do not approach each other in the least but on the contrary stand out from the skull on pedicels and have a distinct burr as in *Bison.* The frontal region between the horn pedicels is not flattened as in the female *Ovibos,* but is elevated and convex. The under side of the skull of the type of *bombifrons* is much injured but one conspicuous character is shown in which it differs from all the other species. This is found in the basisphenoid which is not deflected but has its lower surface in the same horizontal plane as that of the basioccipital and it has a sharp median ridge. The horn cores of *bombifrons* are essentially like those of *Bison* except that they turn downward instead of upward. However, other characters, notably the possession of deep lacrymal fossæ, serve to distinguish it from *Bison.* In consideration of these various characters, the genus *Boötherium* with *Bos bombifrons* as the type seems to merit

[1] This was pointed out by Leidy, who says, "the interfrontal, fronto-parietal, and occipito-parietal sutures are completely obliterated" (*Jour. Acad. Nat. Sci. Phila.,* 2d ser., VII, p. 374, 1869).

[2] This is well shown by Richardson's figure, often cited.—*Zool. Voy. Herald,* pl. IV, fig. 1, 1854.

recognition. Thus far, only one specimen of this genus, the original type, has been found. Specimens of *S. cavifrons* and *S. tyrrelli*, however, have been secured at various localities among which are the following: Fort Gibson, Indian Territory; Council Bluffs, Iowa; New Madrid, Mo.; St. Louis, Mo.; Benton Co., Mo.; Trumbull Co., Ohio; Brook Co., W. Va.; Pennsylvania; Anvik, Alaska,[1] and Bonanza Creek, near Dawson, Yukon Territory. In this large number of specimens, if there were any females at all it is probable that there would be more than one. In order to give any semblance of certainty to the supposition that the differences between *bombifrons* and *cavifrons* are sexual, it is necessary to show that these differences are relatively the same that obtain between the sexes in living species. This cannot be done, therefore it seems safer to treat the two animals as distinct. A much more reasonable assumption would be that *S. cavifrons* represents the male and *S. tyrrelli* the female of one species. The present objection to this is the fact that both have not been found in the same region.

In order to make clear all the points under discussion, photographs are reproduced herewith of skulls of *Ovibos moschatus*, *Boötherium bombifrons*, *Scaphoceros cavifrons*, and *S. tyrrelli*.

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[1] A horn core of *S. tyrrelli* collected by Dr. Arthur Hollick at this locality in 1903 is in the U. S. National Museum.

TABLE OF MEASUREMENTS

	S. tyrrelli	*S. cavifrons*	*O. moschatus*	*B. bombifrons*
Depth of braincase, from superior lip of foramen magnum to top of skull midway between horns	117	181	123	99
Mastoid width	197	212	180	
Interorbital width	191[1]	213[1]	232	150
Width between paroccipital processes at level of tops of protuberances of basioccipital	133	140		
Zygomatic width	211	210[1]		
Width of braincase measured just above the orifices of the temporal canal	118	130	103	105
Inferior lip of foramen magnum to tip of premaxillary	516		462	
Length of palate from interpterygoid fossa to exposed part of vomer	209		186	
Width of palate at m^2	84		79	
Inferior lip of foramen magnum to palatine	184		177	
Inferior lip of foramen magnum to alveolus of m^3	218		217	
Tip of premaxillary to alveolus of pm^1	158		127	
Tip of premaxillary to anterior border of orbit	355		281	
Antero-posterior diameter of orbit	73		63	
Greatest width of basioccipital	72	87	64	64
Length of exostosis from outside of anterior rugose boundary	214	262		
Greatest width of exostosis anterior to bases of horn cores	114			
Width between bases of horn cores across frontals	90	135		137
Antero-posterior diameter of horn core at base	95	110	138	71
Antero-posterior diameter of horn core 10 cm. from base	57	88	83	45
Vertical diameter of horn core at base	72	70	68	69
Vertical diameter of horn core 10 cm. from base	44	62	42	46
Width between broken tips of horn cores	367	553	288	430
Circumference of horn core 10 cm. from base	160	254	220	144
Length of crowns of entire upper toothrow	168		135	
Length of pm^1	19		12	
" " pm^2	19		19	
" " pm^3	19		20	
" " m^1	22.5		25.5	
" " m^2	34		31.5	
" " m^3	49		33	
Width of pm^1	19.5		12	
" " pm^2	25.3		14	
" " pm^3	26.2		14	
" " m^1	28		19	
" " m^2	32		19	
" " m^3	33		18	

[1] Approximate.

EXPLANATION OF PLATES

(About one-fifth natural size)

PLATE XXXVII

FIG. 1. Upper surface of skull of *Ovibos moschatus*. Adult male, No. 14413, U. S. National Museum.

FIG. 2. Upper surface of skull of *Scaphoceros tyrrelli*. Type, No. 2555, U. S. National Museum.

PLATE XXXVIII

FIG. 1. Under surface of skull of *Ovibos moschatus*. Adult male, No. 14413, U. S. National Museum.

FIG. 2. Under surface of skull of *Scaphoceros tyrrelli*. Type, No. 2555, U. S. National Museum.

PLATE XXXIX

FIG. 1. End view of skull of *Scaphoceros tyrrelli*. Type, No. 2555, U. S. National Museum.

FIG. 2. End view of skull of *Boötherium bombifrons*. Type, from collection of Academy of Natural Sciences, Philadelphia.

FIG. 3. End view of skull of *Ovibos moschatus*. Adult male, No. 14413, U. S. National Museum.

PLATE XL

FIG. 1. End view of skull of *Scaphoceros cavifrons*. Type, from collection of Academy of Natural Sciences, Philadelphia.

FIG. 2. Side view of skull of *Scaphoceros tyrrelli*. Type, No. 2555, U. S. National Museum.

PLATE XLI

FIG. 1. Upper surface of skull of *Scaphoceros cavifrons*. Type, from collection of Academy of Natural Sciences of Philadelphia.

FIG. 2. Upper surface of skull of *Boötherium bombifrons*. Type, from collection of Academy of Natural Sciences of Philadelphia.

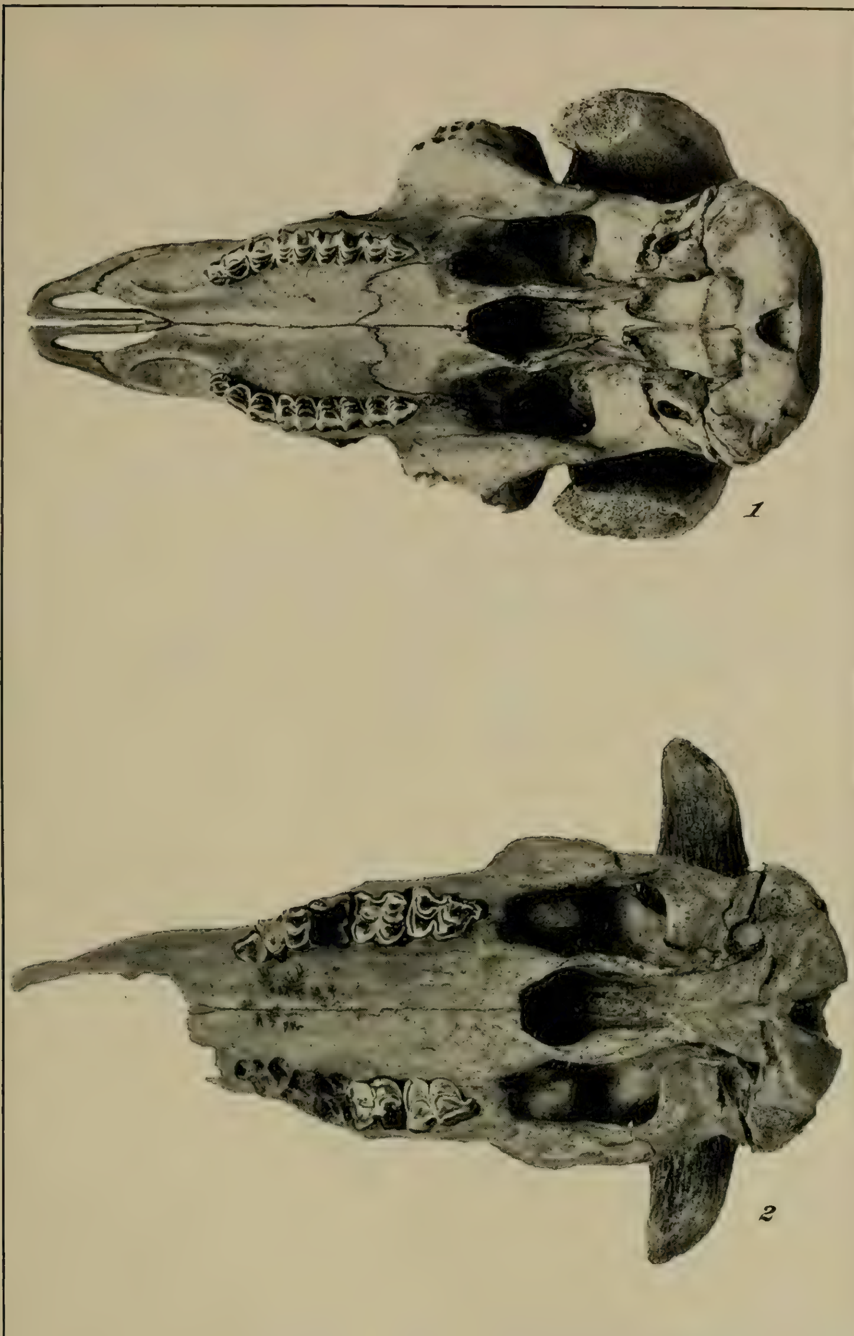
XLII

FIG. 1. Under surface of skull of *Scaphoceros tyrrelli*. Type, from collection of Academy of Natural Sciences of Philadelphia.

FIG. 2. Under surface of skull of *Boötherium bombifrons*. Type, from collection of Academy of Natural Sciences of Philadelphia.

SKULLS OF (1) OVIBOS MOSCHATUS AND (2) SCAPHOCEROS TYRRELLI

(About $\frac{1}{5}$ natural size.)



SKULLS OF (1) OVIBOS MOSCHATUS AND (2) SCAPHOCEROS TYRRELLI

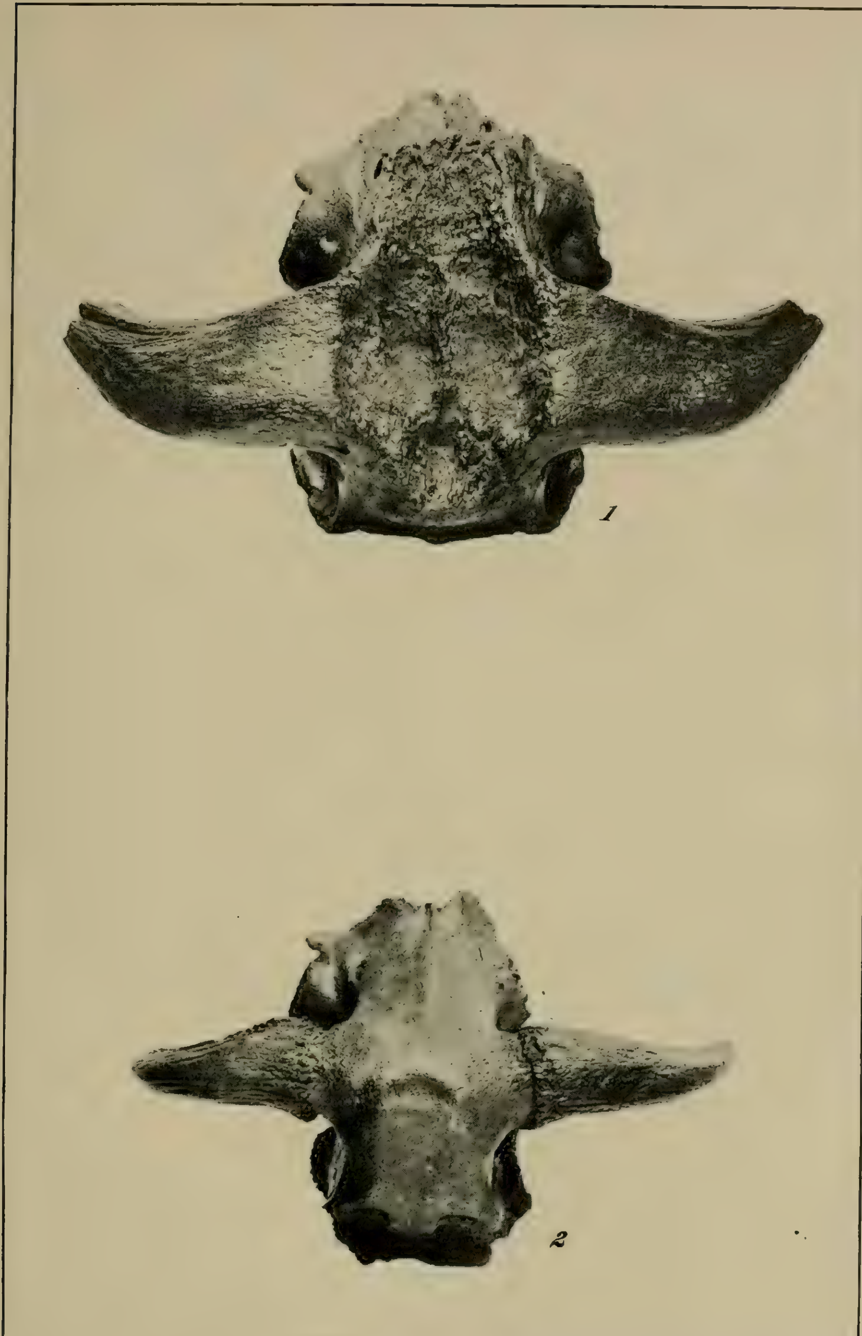
(About $\frac{1}{5}$ natural size.)

SKULLS OF (1) SCAPHOCEROS TYRRELLI, (2) BOOTHERIUM BOMBIFRONS, AND (3) OVIBOS MOSCHATUS

(About $\frac{1}{5}$ natural size.)

SKULLS OF (1) SCAPHOCEROS CAVIFRONS AND (2) SCAPHOCEROS TYRRELLI

(About $\frac{1}{3}$ natural size.)



SKULLS OF (1) SCAPHOCEROS CAVIFRONS AND (2) BOOTHERIUM BOMBIFRONS

(About $\frac{1}{5}$ natural size.)

SKULLS OF (1) SCAPHOCEROS CAVIFRONS AND (2) BOOTHERIUM BOMBIFRONS

(About $\frac{1}{3}$ natural size.)

A NEW GENUS AND SEVERAL NEW SPECIES OF LAND-SHELLS COLLECTED IN CENTRAL MEXICO BY DOCTOR EDWARD PALMER

By WILLIAM HEALEY DALL

Doctor Edward Palmer of the U. S. Department of Agriculture has for a good many years been engaged in Mexico, where his travels have been extensive, collecting plants for the National and other herbaria. In the course of his researches he has from time to time collected landshells, which have been added to the National collection. In a recent expedition to the State of San Luis Potosi, at a height of 7,200 feet above the sea, on the range locally known as the Alvarez Mountains, he obtained a small collection which proved to contain a very remarkable new genus allied to *Holospira,* and several new species of known genera, which form the subject of this paper.

Family UROCOPTIDÆ

HENDERSONIA[1] new genus

Shell discoid, with a single internal parietal lamina, the aperture and part of the last whorl free from the disk and recurved so that the holostomatous aperture lies above the disk and with the plane of its margin nearly or quite parallel with the plane of the shell-coil. Soft parts resembling those of *Holospira.*

This genus is dedicated to Mr. John B. Henderson, Jr., known in connection with his studies of the Antillean landshells. It is an animal of the Urocoptid group which has taken upon itself a discoid form, something hitherto unknown in that assembly and therefore of unusual interest.

HENDERSONIA PALMERI n. sp.

(Plate XLIII, figures 1–4)

Shell thin, depressed, nearly flat above, with the periphery compressed and keeled; the umbilicus wide, shallow, saucerlike, its margin subangular; the suture distinct, rather deep, not channelled but with the whorls between distinctly rounded; nuclear whorl polished, rather prominent, the eight subsequent whorls subequal, closely coiled; the termination of the last whorl divergent, wholly

[1] See note at page 239, *postea.*

free from the body, curved upward with the aperture nearly or quite in the plane of the surface of the spire, dilated and cup-like toward the aperture, the peristome continuous, expanded, and slightly reflected, with an obscure wave on the proximal side; surface striated with feeble lines of growth, color about that of *Polygyra microdonta* Deshayes, a pale horn-color or ashy brown, whitish on the peristome; lumen of the whorls subrectangular before becoming solute; about one fourth of the last whorl contains a single prominent, somewhat oblique elevated lamina on the body side, which diminishes gradually toward each end, the distal end becoming obsolete about the point where the last whorl leaves the coil and begins to grow independently; the wave in the free portion seems to be a reminiscence of the infold in ordinary *Holospiras* but is almost evanescent; diameter, major, 11.5; minor, 9.0; height, 2.0; length of free portion of whorl varying from 1.0 to 3.0 mm. Diameter of aperture, long, 3.0; short, 2.0 mm.

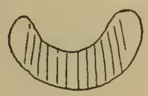
Habitat.—Alvarez Mts., San Luis Potosi, at 7,200 feet elevation; Dr. Edward Palmer, of the U. S. Agricultural Dept. Type No. 110,385, U. S. Nat. Museum.

The remarkable feature of this animal, apart from its discoid form, is the manner in which the termination of the last whorl is freed from the rest and turned upward, as in *Anostoma* or *Hypselostoma,* so that, in crawling, the shell must be dragged on what would ordinarily be the upper surface; a fact which is confirmed by the worn condition in each case of this part of the shell. The aperture strongly recalls that of *Urocoptis,* suggesting at first glance that we have to do with a discoid member that family. However, the internal lamina and the general aspect of the shell, except the umbilical region, are not very unlike the discoid Polygyras.

One of the two specimens containing the animal was submitted to Dr. Pilsbry as the most competent expert in the anatomy of the Pulmonata who reports as follows:

" The specimen was preserved in alcohol and had retreated somewhat more than one whorl within the aperture. It was opened by dissolving the upper surface of the shell with acid until the body could be lifted out unbroken. The foot projected shortly from the rather thick collar of the mantle. It is short and proportioned about as in *Holospira.* The narrow lung extends somewhat more than half a whorl. Its surface is plain, without perceptible venation, except for the long pulmonary vein (*p. v.*). The kidney (*K*) is wedge-shaped and but slightly longer than the pericardium, exactly as in *Holospira* as figured in the Manual of Conchology, *Urocoptidæ,*

pl. 27, fig. 37. It is bright pink and three millimeters long. There is apparently no secondary ureter, nor is there any groove along the intestine (G 4). The intestine is of the usual four-folded type, and penetrates only a short distance behind the heart and kidney.



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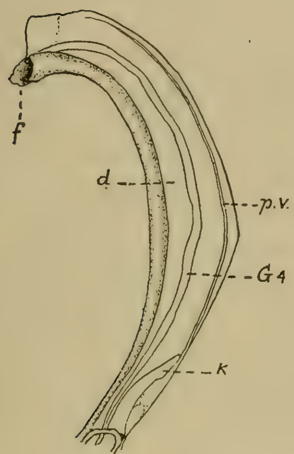

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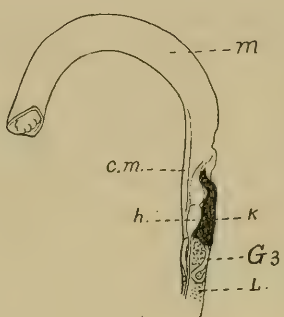

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FIG. 22.—Sketch of jaw of *Hendersonia palmeri.*

FIG. 23.—Teeth of radula, showing (1) rhachidian, first three laterals, ninth lateral and outer lateral.

FIG. 24.—Anatomical details; *k,* kidney; *G.* 4, intestine; *p. v.,* pulmonary vein; *d,* lung.

FIG. 25.—*m,* mantle; *c. m.,* contractor muscle; *h,* heart; *k,* kidney; *G.* 3, undeveloped genitalia; *L,* liver. All magnified; taken from drawings by Dr. H. A. Pilsbry.

The very long liver and the ovotestis occupy the whole of the earlier whorls.

"The genitalia were undeveloped and threadlike. There is a rather long atrium and an excessively long vagina. The penis was represented by a minute budlike tubercle only, and was evidently not yet developed. Its retractor was not seen if present.

"The jaw is very thin, arcuate with faint, well-spaced vertical striæ, as in *Holospira.* The radula has teeth of the *Holospira* type. The rhachidian and six laterals are unicuspid, the cusps obtuse and as

long as the basal plates. The marginal teeth have a small ectocone and the mesocone becomes longer."

In a letter Dr. Pilsbry adds: "This is the most interesting thing which has turned up in Mexico since *Metostracon,* . . . Your surmise that it was a Urocoptid turns out to be correct. The very short kidney, scarcely longer than the pericardium, alone settles it. These organs as well as the jaw and teeth are exactly as in *Holospira,* next to which it evidently belongs."

XANTHONYX POTOSIANA n. sp.

(PLATE XLIV, FIGURES 1, 2, 7)

Shell thin, inflated, white, covered with a conspicuous straw-colored translucent periostracum; whorls three, the first with minute radial riblets broken up into wavy segments or even radially disposed granules, with faint traces of microscopic spiral striation; subsequent whorls faintly spirally striate and with the lines of growth irregularly moderately prominent; last whorl much the largest; suture deep, spire somewhat dome-shaped; aperture with the margin thin and sharp except on the pillar where there is a thin layer of milky white callus; plane of the aperture oblique, the basal margin passing imperceptibly into the arcuate pillar gyrate about a pervious axis; interior of aperture white. Max. diameter of shell 18, min. do. 12, height 14, the aperture 14.5 wide by 13.3 mm. high.

Habitat.—State of San Luis Potosi, on the Alvarez Mountains, at a height of 7,200 feet.

This is the largest and most turbiniform species of *Xanthonyx* known. None of the specimens contained the animal, though ten of the shells, of various ages, were obtained.

The type is No. 110,396 U. S. Nat. Museum. With this species were found *Epiphragmophora pressula* Morelet, *Microceramus mexicanus* von Martens, a *Holospira* which appears to be the true *H. pilocerei* Pfeiffer, *Glandina bellula* Crosse and Fischer, and another form which is perhaps a variety of it, beside young specimens of a *Glandina* too immature to be positively identified.

STREPTOSTYLA POTOSIANA n. sp.

(PLATE XLIV, FIGURE 4)

Shell moderately large and solid, opaque white with a brilliantly polished translucent yellowish-olive periostracum, with occasional darker zones axially arranged; the periostracum after the death of the animal rapidly peels off, leaving the surface white and smooth;

whorls in the adult about seven, smooth, not wrinkled axially in front of the very distinct suture; spire rather blunt, the whorls between the sutures convex; sides of the last whorl somewhat parallel, apex and base of the shell about equally tapering; outer lip sharp, slightly sinuous; the aperture narrow behind and rather wide in front, the axis and pillar twisted as usual in the genus. Length of shell 40, of aperture 28, of last whorl 34 mm.; max. diameter 15.5 mm.

Habitat.—Alvarez Mountains, State of San Luis Potosi, at a height of 7,200 feet.

Type, No. 110,395 U. S. Nat. Museum.

This species has a straighter columella than any of its size, and in a general way appears nearest allied to *S. sallei* and *S. edwardsiana* Crosse and Fischer, from which it is sufficiently distinct. It appears, from the number collected, to be quite common, though few of the specimens were adult or in perfect condition.

STREPTOSTYLA PALMERI n. sp.

Shell small, slender, subtranslucent, with a pale thin straw-colored periostracum axially zonate with lighter and darker streaks following the lines of growth; whorls six, the last much the largest, spire rather blunt, the suture evident but not deep, appressed, and without axial wrinkles in front of it; pillar white, slightly thickened and twisted about a pervious axis; length of shell 24.5, of aperture 20, of last whorl 22.25 mm., max. diameter 9.5 mm.

Habitat.—With the preceding species.

Type, No. 110,394 U. S. Nat. Museum.

This approaches *S. sallei* Crosse and Fischer but is more slender, has a shorter spire and is of a lighter make and color. From *S. potosiana* of the same size it is distinguished by its more slender build, more produced spire, and pervious axis, as well as by the differences in color. It has a shorter spire than, and different color from, *S. shuttleworthi* Pfeiffer.

SCHAZICHEILA PALMERI n. sp.

(PLATE XLIV, FIGURES 3, 5)

Shell compact, elevated, with a rather pointed spire, well marked suture and about five whorls; color varying from white, through straw color to pale olive, yellow, or various shades of salmon color, surface polished but not smooth, being rather rudely marked at intervals by prominent incremental lines and faint spiral or irregular striulæ seldom visible without a glass; aperture gibbous, the

outer lip patulous behind and then receding to the suture, forming a shallow sulcus, more or less reflexed below, the margin continuous across the body with a groove behind it and a rather rude thin layer of callus covering the umbilical region; the inner part of the lip is white and somewhat thickened, in colored individuals the color appears in the throat and with emphasis; the base is full and rounded, the periphery destitute of any keel; there is more or less variation in size, extremes measuring:

Height	Max. diam.	Min. diam.	Aperture
10.0	12.5	9.5	6.0 mm.
8.5	11.0	8.0	5.0 mm.

The outer surface of the operculum is rudely striated, the inner polished, the color varies with that of the shell. It is solidly calcareous.

Habitat.—In the Alvarez Mountains with the preceding species and at San Dieguito, San Luis Potosi.

Type, No. 110,397 U. S. Nat. Museum.

The species approaches *S. pannucea* Morelet, and *S. alata* Menke, is more elevated than the former and less so than the latter. The sutures are less deeply impressed than in *alata* which seems its nearest relative. The superior sinus seems less deep than in either of the species with which it is above compared, but this feature varies with age. Many of the specimens had been opened by mice who extract the animal through a neat little hole in the side of the shell as they would take a kernel from a nut.

HELICINA ZEPHIRINA Duclos

Habitat.—Alvarez Mountains, San Luis Potosi, with the preceding.

HELICINA ELATIOR von Martens

Habitat.—With the preceding and also at San Dieguito.

According to Dr. Pilsbry this is *Helicina zephirina* Duclos, var *elatior* von Martens, the *H. turbinata* Pfeiffer as of Wiegmann, but not the *H. turbinata* of Sowerby. A large series having been obtained, it is quite evident that it is entirely distinct from *H. zephirina,* and therefore von Martens' varietal name may be raised to specific rank.

PLANORBULA OBSTRUCTA Morelet

Quite a number of specimens were obtained from a small pool in the same vicinity as the preceding species and that which follows.

SPHÆRIUM MEXICANUM n. sp.

(PLATE XLIV, FIGURE 6)

Shell small, shape subrhomboidal, the ends nearly equally rounded, the beak nearer the anterior end; protoconch smooth, ovate, not prominent; umbonal region with about ten concentric waves (sharp at the crest, the interspaces wider) outside of which the sculpture suddenly becomes much less prominent, in fact hardly more than concentric striation; the surface is covered with a pale olive periostracum; right valve with a single rather obscure cardinal, and a pair each of disproportionately strong anterior and posterior laminæ, the inner faces of which show distinct fine granular rugosity; pallial line obscure, adductor scars distinct. Length 5.5, height 4.25, diameter 3.0 mm. Type, 110,405 U. S. Nat. Mus.

Habitat.—Alvarez Mountains with the preceding.

This is very distinct from any other North American species, and with the exception of *S. costaricense* Prime, is the most southern of them all. Unfortunately only a single valve was obtained, though this is in perfect condition.

SPECIES OBTAINED ON OTHER OCCASIONS

The following species are recorded as obtained by Dr. Palmer on other occasions at the localities mentioned.

Physa berendti Dunker. Twenty-five miles southeast of Saltillo, and at Santa Maria del Rio.

Physa mexicana Philippi. Nombre de Dios, Durango, and at the town of Durango.

Physa boucardi Crosse and Fischer. Nombre de Dios, Durango.

Planorbis tenuis Philippi. Nombre de Dios.

Planorbis liebmanni Dunker. Topolobampo, Sinaloa.

Planorbis tumidus Pfeiffer. Nombre de Dios.

Othalicus undatus Bruguière. Manzanilla, Colima.

Praticola berlandieriana Moricand. "Mexico."

Praticola griseola Pfeiffer. "Mexico."

Polygyra carpenteriana Bland. "Mexico."

Bulimulus schiedeanus Pfeiffer. "Mexico."

The four immediately preceding species were probably obtained at some point on the low coastal plain of northeast Mexico.

Anodonta exilior Lea. Durango City.

Doctor Palmer has collected a considerable number of other interesting mollusks, at various times, which have been put in the National collection without retaining a list, and which therefore cannot be enumerated here.

EXPLANATION OF PLATES

PLATE XLIII

FIGS. 1–4. *Hendersonia palmeri* Dall, n. g. et sp. Fig. 1, view from below; 2, profile; 3, specimen with the whorl broken away to show internal spiral lamina; 4, view from above; all figures magnified two and one-third diameters. See page 187.

PLATE XLIV

FIG. 1. *Xanthonyx potosiana* Dall, n. sp., from above, magnified. See page 190.

FIG. 2. The same in profile.

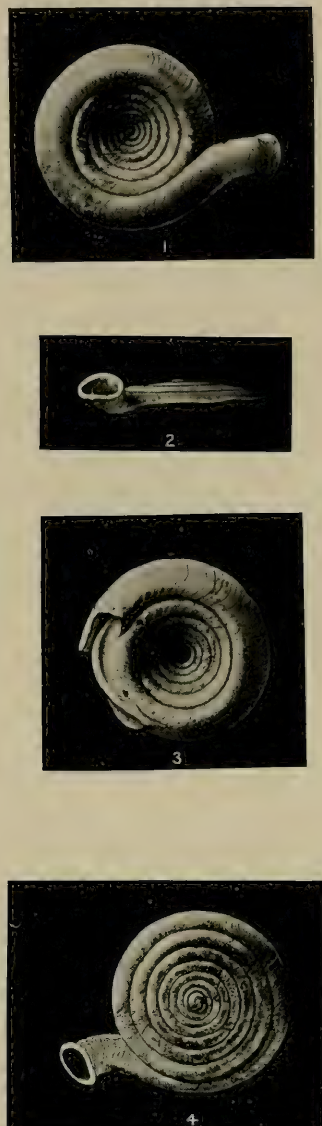
FIG. 3. *Schazicheila palmeri* Dall, n. sp., magnified. See page 191.

FIG. 4. *Streptostyla potosiana* Dall, n. sp., nat. size. See page 190.

FIG. 5. *Schazicheila palmeri* Dall, from above, magnified. This specimen has the sinus at the aperture less developed than usual in adults. See page 191.

FIG. 6. *Sphærium mexicanum* Dall, n. sp., magnified about 5½ diameters. See page 193.

FIG. 7. *Xanthonyx potosiana* Dall, n. sp., from below, magnified. See page 190.



CENTRAL MEXICAN LAND SHELLS

CENTRAL MEXICAN LAND SHELLS

THE FAMILY OF CYPRINIDS AND THE CARP AS ITS TYPE

By THEODORE GILL

By far the largest element of the fish fauna of the fresh waters of the northern hemisphere is the family of Cyprinids represented by the common carp, goldfish, dace, chub, bream, and their numerous relations. These have attracted considerable attention in Europe, but in America they have been comparatively neglected, so that but little is known of their habits. Nevertheless they may repay attention, for very interesting peculiarities are manifested by some of the species, especially during the breeding season, and some unexpected results may be obtained by observation of others. One of the main reasons for inattention to the species is the want of knowledge of how and what to look for and the scattered nature of the data already published relating to the economy of the species of the family. To supply to some degree at least this deficiency the following notes, gathered from many sources, are offered.

The popular names applied to the Cyprinids are numerous and in Europe most of the species are well distinguished and provided with distinctive names. The early English immigrants to America brought over a number of such names and applied them in a reckless manner to new species they found in the new land. None of the American species were much like any of the English ones and different persons were differently impressed by their appearance and consequently applied names expressing such differing impressions. The result is that on the one hand the same American species may be variously known as dace, roach, chub, or bream, and on the other hand each of those names may be applied to very different species. The old names are of much philological and historical interest and therefore the true owners of the names current in America are illustrated and the history of such names briefly indicated.

Relations of the Cyprinids

The family of Cyprinids is one of four now generally recognized, either as independent families or subfamilies, belonging to a group (superfamily of Cyprinoideans or suborder of Eventognaths) which is itself a major subdivision of the order of Plectospondyles.

The families, besides the Cyprinids, are the Catostomids, Cobitids and Homalopterids;[1] the four may be recognized by the following selected characters:

The *Catostomids* or suckers have the upper margin of the mouth partly formed at the sides by the supramaxillary bones, the pharyngeals are falciform and armed with a single comb-like row of numerous more or less compressed teeth; there is no palatal pad, and the air-bladder is either bipartite or tripartite.

The *Cyprinids* or carp-like fishes have the upper margin of the mouth formed entirely by the intermaxillary bones, the pharyngeals are truly falciform and armed with few teeth in any row; there is a molariform pad behind the palate, and the well-developed air-bladder is generally bipartite, being divided into two chambers, an anterior and posterior, but sometimes tripartite, the posterior chamber itself being transversely constricted.

The *Cobitids* or loaches have the upper margin of the mouth, as in the Cyprinids, formed entirely of the intermaxillaries, the pharyngeals are only subfalciform and a single row of teeth is borne on a ridge-like margin; there is no molariform palatal pad, and the air-bladder is more or less reduced, disconnected from the stomach, divided into lateral halves enclosed in a bony capsule, and often open to the skin on the sides.

The *Homalopterids* have the upper arcade of the mouth formed exclusively by the intermaxillary bones, the pharyngeal bones are most like those of the Cobitids and the teeth in considerable number and uniserial; there is no palatal molariform pad, and the air-bladder is suppressed or rudimentary and representative of the anterior chamber of the Cyprinoid bladder, divided into lateral halves which are enclosed in a bony capsule.[2]

The geographical distribution of these groups is noteworthy. The Catostomids are almost peculiar to North America, the only extra-American species being several Siberian forms of the genus *Catostomus* and one generic type peculiar to eastern Asia (*Myxocyprinus*). The Cyprinids, as will be more fully explained further

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[1] The four families were first named and defined as now understood by Gill (*Proc. Acad. Nat. Sc. Phila.*, 1861, pp. 6–9), and have been adopted by American ichthyologists generally and by Smitt (1895); the Cyprinidæ, Cobitidæ and Homalopteridæ were recognized by Fatio (1882) and the four groups have been ranked as subfamilies by Boulenger (1898 and 1904).

[2] A remarkable generic type from Borneo (*Gyrinochilus*) with double branchial apertures, a mouth resembling a tadpole's and a small but free air-bladder was described in 1902 by Vaillant. It is the type of a peculiar family, Gyrinochilidæ, and not a member of the family Homalopteridæ.

on, occur wherever any other Eventognaths do. The Cobitids are mainly Asiatic, but several are African and three species have extended into Western Europe. The Homalopterids are confined to India and the continent and islands to the eastward.

Characteristics of the Cyprinids

The form varies from high as in the breams and catlas to elongate as in the American *Phenacobius* and *Platygobio* and the African *Chelæthiops,* the belly being generally rounded, rarely (as in the sichling and *Chelæthiops*) compressed and trenchant; the scales are cycloid, confined to the body (not extending onto the head)—rarely wanting; the lateral line is more or less decurved and parallel with the belly, rarely atrophied; the fins, especially the dorsal and anal, vary greatly in size and relative position.

The carp-like fishes are the "leather-mouthed fish" of Izaak Walton; they have no teeth in the jaws, but to some extent divide or prepare their food by the operation of teeth on the concave side of the sickle-like pharyngeal bones which are just behind the gill-arches. The character was long ago observed but not understood and fishes distinguished thereby were designated by the English fishermen as "leather-mouthed."

"By a leather-mouth," Walton explained, "I mean such as have their teeth in their throat, as the chub or cheven, and so the barbel, the gudgeon, the carp, and divers others have." These "teeth in their throat" are, as just remarked, really on special bones behind the gills called "pharyngeal."

The pharyngeal bones and especially the teeth which beset them, are so much used in classification that a little attention to them is called for here. They were first utilized for the arrangement of the genera by Agassiz (1835) and later much more extensively by the Austrian naturalist, J. Heckel (1843) and ever since have been made use of in all works treating of these fishes.

The pharyngeal bones are not only immediately behind the branchial arches, but are considered to be "serially homologous" with them; in other words, derived from primitive generalized arches but greatly modified from them. They tend to preserve the same general form as the arches and are more or less falciform, or like a sickle, having a short base of insertion or handle and an ample arched body. In the suckers or Catostomids these bones are provided with numerous processes or teeth inserted at right angles to the axis of the bone. In the carp-like or Cyprinoid fishes, the teeth are in reduced number and variously modified. There is

always a main row, generally of five or about five teeth, very often a secondary row, and in other types a third one.

In the common carp (*Cyprinus*) there are generally said to be three rows of "molar" teeth, but there are only three teeth in the main row and one in each of the others; in the nearly related goldfish (*Carassius*) there is only one row of teeth which are "scalpriform"; in the barbel (*Barbus*) the teeth are again in three rows (five in the main one, three in the next and two in the third) and "cochleariform" or excavated like a spoon. These kinds of teeth are coördinate with a very long intestine.

In the chub and roach (*Leuciscus*) the teeth have pinched or "contusory" crowns and are uniserial and five or six in a row; in the rudd (*Scardinius*) they are "raptatorial" and in two rows (five in main, three in secondary). The intestinal canal concomitant with these hooked teeth is more or less abbreviated.

Such are examples of four of the modifications of the pharyngeal dentition recognized by Johann Jakob Heckel. That author, as the result of prolonged studies of the dental characteristics of the Cyprinids, formulated in 1842 an elaborate classification of the teeth and this has been the basis of and standard for most of the work since done on the parts in question. Heckel's essay was buried in a publication accessible to but few—Joseph Russegger's "Reisen in Europa, Asien und Afrika," etc. Most of it is contained in the first volume (second part, pp. 1001–1043). An author's edition of Heckel's ichthyological contributions to Russegger's work was published in 1843 (258 pp., 22 pl.).

The species were ranked under genera characterized in the first place by the form and number of teeth, the genera were combined under tribes distinguished by characters drawn from the mouth, lips, cirrhi, position of preopercle, and form of dorsal and anal fins as well as their spines. Thus was a natural classification attempted. To facilitate comprehension and description of the pharyngeal dentition, a detailed classification of the kinds of armature independent of the collective characters of the tribes was prefixed. On account of its usefulness and the rarity of the work in which the essay was published the following outline is given:

I. MACROENTRI. (Elongate alimentary canal.)
  A. DENTES EXCAVATI. Hohlzähne. (Teeth excavated.)
    Dentes cochleariformes. Löffelzähne. (Teeth spoonlike.)—*Barbus barbus.* (Barbel.)
    Dentes paleæformes. Schaufelzähne. (Teeth spadelike.)—*Capoeta* (or *Scaphiodon*) *capoeta.* (Capoeta.)

B. Dentes masticatorii. Kauzähne. (Teeth for grinding.)
  Dentes aggregati. Pflasterzähne. (Teeth crowded.)—*Labeo niloticus.*
  Dentes molares. Mahlzähne. (Teeth molariform.)—*Cyprinus carpio.* (Carp.)
  Dentes calyciformes. Becherzähne. (Teeth cuplike.)—*Carpio kollarii.* (Hybrid between Carp and Karass.)
  Dentes scalpriformes. Meisselzähne. (Teeth chisellike or scalpriform.)—*Carassius carassius.* (Karass.)
  Dentes pectiniformes. Kammzähne. (Teeth comblike.)—*Catostomus commersonii.* (Sucker.)
  Dentes cultriformes. Messerzähne. (Teeth knifelike or cultriform.) —*Chondrostoma nasus.*

II. Brachyentri. (Shortened alimentary canal.)

C. Dentes uncinato-submolares. Hakenzähne mit Kauflächen. (Teeth hooked and with grinding surfaces.)
  Dentes clavati. Keulenzähne. (Teeth clublike.)—Tinca tinca. (Tench.)
  Dentes contusorii. Drückzähne. (Teeth bruising.)—*Rutilus rutilus.* (Roach.) *Abramis brama.* (Bream.)
  Dentes prehensiles. Greifzähne. (Teeth prehensile.)—*Notropis cornutus.* (Redfin.)

D. Dentes uncinato-subconici. Hakenzähne ohne Kauflächen. (Teeth hooked and without grinding surfaces.)
  Dentes raptatorii. Fangzähne. (Teeth raptatorial.)—*Leuciscus cephalus.* (Chub.) *Scardinius erythrophthalmus.* (Rudd.) *Idus idus.* (Ide.) *Aspius aspius.* (Asp.) *Gobio gobio.* (Gudgeon.)
  Dentes voratorii. Würgezähne. (Teeth for strangling.) *Barilius niloticus. Danio alburna.*

It must be distinctly understood, as Heckel himself recognized, that this arrangement is one of the pharyngeal teeth alone and not one of the fishes. Nor is the arrangement of the genera under tribes a natural one. A natural classification of the family is still a desideratum and one not likely to be discovered for many years to come. Only by a comparative study of the anatomy and especially of the bones can a natural system be obtained. Two most important agencies will be requisite to this end, (1) a collection of skeletons of the genera (disarticulated so that all parts may be examined) and (2) a man prepared to utilize it; the former might be procured without extreme difficulty and without excessive cost but for the latter we may have to wait for a long time.

The pharyngeal bones of the principal European genera of Cyprinids have been well illustrated by Dr. Victor Fatio in his excellent work on the fishes of Switzerland and these have been reproduced for the present article.

On or behind the palate is an apparatus against which the pharyngeal teeth work in the tearing and mastication of the ingested food.

The palate, as Smitt explains, is lined with a mucous membrane, thickly covered with papillæ and arranged in longitudinal folds, "which is continued backwards, smooth but with large gustatory papillæ, on the tumid, soft, cushion-like mass of muscles and fat—the carp's tongue so highly prized by the epicure—situated under the posterior part of the cranium. Backwards and downwards from the body of the occipital bone runs an osseous (pharyngeal) process, pierced at its base for the passage of a blood vessel (*aorta abdominalis*), the under surface of which process, just at the end of the said cushion, is shod in a depression with a cartilaginous, more or less hard and tumid disk, the so-called *carp-stone* or *pharyngeal cartilage*," by the Germans called *Karpfenstein*, by the French *la meule*. This carp-stone is characteristic and its modifications serve to indicate the affinities of genera; for example, in the carps, gudgeons and tench, it is triangulate and very hard with a yellowish-brown surface; in the barbels it is also triangulate but semi-cartilaginous, thus differing from that of the Cyprinines and more like that of the other European forms; in the chubs, daces and breams it is somewhat pentagonal or oval, comparatively soft and elastic, and has a whitish surface. The carp-stone has been entirely neglected by American naturalists, but its characteristics have been more or less used by some European ichthyologists, and especially by Fatio, for the distinction of genera of the old world. The illustrations given by Fatio are in a plate accompanying this contribution. They will serve as a basis for comparison of American types.

The ingesta, or at least some of them, appear to be soon reduced; "as a rule food passes rapidly through the intestinal canal; a goldfish fed with wheat-bread passes after some minutes a white vermiform mass of excrement, which hangs from the vent."

The diet is in accordance with the nature of the pharyngeal teeth; fishes with hooked and pointed teeth and shortened intestines being carnivorous, while those with molar teeth and extended intestines are more or less herbivorous.

Distribution

Somewhere over a thousand species of this family are known. Asia, and especially India, harbors the greatest number; Africa is less rich, Characinids to some extent taking their place. North America, with about two hundred and fifty species, is on a par with India. None are found in South America, where their place is entirely taken by the Characinids; Australia also has none.

Two species have been domesticated and extensively introduced

into many countries. One is the carp (*Cyprinus carpio*) utilized for food purposes, and the other the goldfish (*Carassius auratus*), so well known as the tenant of aquaria and globes in numerous houses. Other European species domesticated to a slight extent are the ide, id or nerfling (*Idus,* or *Leuciscus, idus*) and the tench (*Tinca tinca*). All these have been imported into the United States from Europe.

In the aggregate the Cyprinids supply a large proportion of the fishes which serve for the consumption of the inhabitants of the inland countries whose waters they frequent. In the eastern and central portions of the United States, however, they are regarded with little favor, as they are mostly too small to furnish food to the table or sport to the fisherman. Their numbers and their presence everywhere, nevertheless, force them on the attention of the inhabitants, and even if they fail to appeal to the palate of the epicure or to satisfy the desire of the " scientific angler," their pursuit gives pleasure to thousands of juvenile anglers; and men, too, after all are boys of riper growth and, disdaining the capture, yet take. Old Ausonius has given a vivid picture of the youthful angler which may recall boyish days.

Poised on a rock, hid from fish's gaze,
His slender line the cautious angler plays,
Inclining downward from his shadowed nook,
The pliant rod, whose tip with graceful crook,
Yields gently to the plummet's chosen weight;
The eager fish quick bites the flattering bait,—
Then writhes in terror at the pang, that thrills
From the barbed iron through his wounded gills,
Down sinks the float, and, with repeated nod,
The struggling captive agitates the rod,—
The ready stripling, through the hissing air,
From right to left now springs the straining hair,
And, flung upon the shore, his welcome prize
Flounces awhile in death, and gasping dies.

In spite of the fact that the family is abundantly represented in the waters of the most progressive nations of the globe as well as others, the paleontological history is almost unknown. Numerous remains have been found of middle and later tertiary age (not older than the oligocene) but all have been identified with existing genera. Not a single well differentiated and determined extinct genus has been discovered and no light has been thrown on the past history or origin of the family. A few distinct generic names, it is true, have been proposed for extinct species, but the remains have not been sufficient to allocate them in the system. The sup-

posititious "new genera" have been based almost entirely on pharyngeal bones and teeth.

Sexual Differentiation

As the breeding season approaches, and during that season, the males of many species assume and exhibit brilliant colors and marked cutaneous excrescences. The colors are in some extremely vivid and chiefly bright red, blue, and steel color; the excrescences or tubercles vary in position; they are mostly on the head and especially about the snout, but in some are also developed on the sides and on the fins. These excrescences are correlated with the manner in which the males approach the females and attach themselves during the period of oviposition, and there appears to be considerable variation, according to species, in the manner of juxtaposition of the male and female during the process of oviposition.[1]

The eggs are mostly laid on the ground and, after fertilization by the males, left to themselves. Of some species, however, the parents, generally only the males, assume charge of the eggs and watch over them until they are hatched. None of the European fishes are known to do so, but the American horned dace (*Semotilus atromaculatus*), black-headed dace (*Pimephales promelas*), and stoneroller (*Campostoma anomalum*) do, and their actions have been especially studied by Professor Reighard. But the most remarkable mode of oviposition is that manifested by the Central European bitterling (*Rhodeus amarus*). The sexual differences are well marked; the male being larger and brilliantly colored in the breeding season. The ripe female has a long ovipositor in front of the anal fin, by which she introduces egg after egg into a gill of a fresh-water mussel (Unionid) and therein the egg is developed and hatched. Nothing like this has been found in America where the mussels so abound, but it is not impossible that analogous species may occur here.

Naturally the habits of the common and widely distributed carp are best known, and a summary of what has been learned about it may give not only its history but hints as to points to be observed for other species of the family.

Life History of the Carp

The genus *Cyprinus*, though designated as the type of the family and giving name to it, is only to that extent typical, it being a group

[1] Another kind of sexual differentiation will be noticed in connection with the Tench (p. 210).

of only two known species at most, of temperate Asiatic origin. It is characterized by an oblong compressed body, large scales, two pairs of barbels, long dorsal with an osseous (third) ray in front, short anal, and pharyngeal teeth which are mostly molariform and in three rows (3|1|1—1|1|3). The principal species is the well known common carp (*Cyprinus carpio*); a doubtful second is a peculiar Chinese species with larger scales (*Cyprinus fossicola*).

The common carp (*Cyprinus carpio*), in its most natural condition, has its body covered with scales of moderate size, thirty-five to forty along lateral line and in five or six longitudinal rows between the line and fore part of back. In artificial condition sports from this standard have been derived and two varieties largely cultivated. One is the mirror carp, in which the body has become for the most part naked, but very much enlarged scales developed in three rows, along the lateral line on the tail, on the back below the dorsal fin, and below above the anal; the other is the leather carp, in which the scales are wholly or almost entirely lost.

The carp's behavior is well worthy of attention. In water which it has not been able to befoul too much, it may be seen listlessly swimming about with the dorsal folded backwards, the anal slightly less so, the caudal lazily moved from side to side, the pectorals horizontal or slightly oblique, and the ventrals folded on the abdomen. Tired even of this, it retires down to the bottom and there rests largely on its ventrals, now horizontally outspread and with the surface touching the ground. It never ceases its inspirations which occur mostly from twenty to forty times a minute, rarely more or less. The gulping at the mouth is quickly succeeded by the uplift of the gill-cover; sometimes they appear to be almost synchronous with each other. It may frequently ascend to the surface to take in a breath of free air. Indeed, according to some authors (Smitt for example), "during the warm season" the carp "soon dies of suffocation if prevented from coming to the surface to breathe." The commotion which it causes in the water by such excursions has given rise to a curious superstition in Ireland. Frank Buckland was told that "fairies could be seen dancing on bright moonlight nights in a certain lake" of that favored land of the fairies, and he went to enjoy the sight. "The water was very still but showed rings innumerable. These," he found, "were caused by large carp coming to the surface and smacking their lips as they took in great gulps of air."

The carp is ubiquitous and will live in almost any water, but experienced carp-culturists (*e. g.*, R. Hessel) insist that it is "par-

tial to stagnant waters or such as have not a too swift current, with a loamy, muddy bottom and deep places covered with vegetation"; further, "it is an advantage that the carp is able to live in water where other fishes could not possibly exist; for instance in the pools of bog-meadows or sloughs." Nevertheless, "it is not by any means to be inferred from this that the best locality for carp ponds of a superior kind" should be "in such situations. The presence of too much humic acid is unfavorable to the well-being of the carp." In short, its preference generally appears to be for "places with a luxuriant vegetation, being by no means averse to a muddy bottom, but requiring clear water and free access to the sunlight."

But it is not even confined to the fresh water; it is, to some extent, tolerant of salt; in the words of Smitt, it can "endure salt water." In the Caspian sea even, if Pallas is to be credited, "the carp lives in water so salt that hardly any other fish can sustain life there." Its occurrence in brackish waters in many places has been recorded.

Although individuals endure for a time wide differences of temperature, they flourish best in water which is not overheated or too cold. Tropical countries and those where cold prevails for nearly half of the year, as in Scandinavia or the northern part of the Canadian Dominion, are not favorable to their continuous development. They are indeed "highly sensitive to heat and cold."

They manifest the effect of cold by seeking warmer resorts and by abstention from food. "In the moderate zone" (*e. g.*, Central Europe or the middle United States), "the carp will, at the beginning of the cold season, seek deeper water to pass that period in a kind of sleep. This will sometimes occur as early as the beginning of November if the winter should set in early; and it is to be remarked that they will retire at an earlier period in ponds than in rivers. They do so always in groups of from fifty to one hundred and more. They make a cavity in the muddy ground, called a 'kettle'; in this they pass the time until spring, huddled together in concentric circles with their heads together, the posterior part of the body raised and held immovably, scarcely lifting the gills for the purpose of breathing, and without taking a particle of food. They do not take any food from the beginning of October and continue to abstain from it, in some countries, until the end of March, and in colder districts even somewhat later."

Tenacity of life is another attribute of the carp. It is claimed that in this respect the carp surpasses all its compatriots except the eel. This characteristic enhances its commercial value as a market fish, for it can be carried for long distances and displayed on the

fish-stall alive. "Packed in damp moss or ice and with a bit of bread dipped in spirits in the mouth, the carp can live at least twenty-four hours." It can also endure deprivation of water for quite a long time. Smitt tells of a mirror carp sent to the Royal Museum of Stockholm in a bucket and kept alive for several days. "One morning it was found to have leapt out of the tub, and lay on its side apparently dead. It was restored to the water, but floated belly upwards and did not move a limb. It was then given a dessert-spoonful of spirits, and began after some minutes faintly to move its pectoral fins. After a quarter of an hour the dose was repeated, and within an hour the fish moved about with ease, as if nothing had happened." A judicious admixture of spirits and water, it seems, is not to be restricted to man!

Omnivority has truly been attributed to the carp; it will feed not only on fish, flesh and fowl, but on vegetables as well as all kinds of small organisms. "After its first awakening from the long winter sleep, it seeks most diligently after the contents of the seeds of the *Nuphar luteum* and *Nymphœa alba,* the yellow and white water-lily, the *Phellandrieum aquaticum, Festuca fluitans,* etc."[1]

The faculty of rumination has been claimed for the carp. W. Houghton (1867) quotes a communication by Richard Owen affirming that a carp, "after having fed voraciously on ground bait," when "laid open, shows well and long the peristaltic movements of the alimentary canal; and the successive regurgitations of the gastric contents produce actions of the pharyngeal jaws as the half-bruised grains come in contact with them, and excite the singular tumefaction and subsidence of the irritable palate, as portions of the regurgitated food are pressed upon it. The shortness and width of the œsophagus, the masticatory mechanism at its commencement, and its direct terminal continuation with the cardiac portion of the stomach relate to the combination of an act analogous to rumination, with the ordinary processes of digestion, in all fishes possessing these concatenated and peculiar structures."

It need only to be added that the "analogy" in this case is, at best, remote.

The awakening from their winter sleep is followed not long after (about May) by the season for spawning. The female has become

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[1] The *Nuphar* and *Nymphœa* are now called by many botanists *Nymphœa* and *Castalia;* the plant called by Hessel *Phellandricum aquaticum* is better known as *Œnanthe phellandrium* or fine-leaved Œnanth; it is not a native American plant; the *Festuca fluitans* is popularly known as the floating fescue or water grass.

turgid about the abdomen, the ovaries fully developed and the eggs ripe. The number of eggs is approximately proportioned to the size of the ováries and consequently that of the mother-fish; in one of four or five pounds weight there may be 400,000 to 500,000 or even more. In one weighing sixteen and a half pounds, whose ovaries weighed five and one half pounds, over 2,000,000 eggs were accounted for. The male has assumed external sexual characteristics in the form of protuberances, like warts, on the skin of the head and back, which disappear after the spawning season. His color also brightens. Some days before spawning, both sexes show increased vivacity, and " rise more often from the depths below to the surface." Two or three or more of the males keep near a female and the latter swims near the surface followed by the males. " The female prefers spots which are overgrown with grasses and other kinds of aquatic plants." The males follow close to the very water's edge. " They lose all their timidity and precaution, so that they may be taken quite easily. They lash the water in a lively way, twisting the posterior portion of the body energetically, and shooting through the water near the surface with short tremulous movements of the fins. They do so in groups of two or three males to one female fish and forming an almost compact mass. This is the moment when the female drops the eggs, which immediately are impregnated by the milter. As this process is repeated several times, the female drops probably only from four hundred to five hundred eggs at a time, in order to gain resting time, so that it will require days and weeks " before she gives up " the last egg." These eggs are adhesive, not detached, and adhere in lumps to the object upon which they have fallen. They average about a millimeter and a half in diameter and are of a yellowish color.

As soon as the eggs have left the body they begin to swell and their mucus-like investment serves to fasten them to " some aquatic plant, stone, or brush-wood. Those eggs which have no such object to cling to are lost." The eggs develop rapidly and development is hastened by increased warmth. Under ordinary conditions, " as early as the fifth or sixth day the first traces of dusky spots, the eyes, will be visible, and towards the twelfth, or at the latest the sixteenth, day the little embryo fish will break through its envelop."

After the yolk-bag has been absorbed, the young seek food for themselves and feed mostly on minute rotifers and copepod crustaceans, later on larval insects (the larvæ of mosquitoes are especially acceptable), and in a few weeks are prepared to add to their diet. If the food be abundant, by the time cold weather causes cessation

of feeding, the fishes of the year will weigh a pound or more; recommencing with nearly that weight the next spring, at the end of the second summer they will weigh three pounds, more or less. In the spring of the third year they will be prepared to do their share in the perpetuation of the race. They continue to grow almost indefinitely and it has been claimed that a weight of a hundred pounds and an age of a hundred and fifty years have been attained, but fifty pounds is almost a maximum weight and extremely rarely realized.

According to some authors, especially Hessel, "some time before the spawning season sets in, the falling out of the pharyngeal teeth takes place" and "these grow anew every year." If such is the case, confirmation is required and details are needed; alcoholic specimens appear to contradict the claim.

Not all carp develop the sexual organs. "Sterile carp are not uncommon, and have always been highly esteemed for their fat, delicate flesh. An English fisherman of the name of Tull discovered a method of castrating carp in order to fatten them with better success." The method of castration was detailed in "An Account of Mr. Samuel Tull's Method of Castrating Fish," by W. Watson, in an article in the "Philosophical Transactions" for 1754 (XLVIII, 870–874). Tull castrated "both the male and female fish" and thought that "when fishes have spawned a few weeks, they are fit for the operation." Carp culturists do not appear to have availed themselves of this method of improving the flesh.

The carp, at the present day is, with one exception, the most widely distributed of the family and its name the most generally diffused. The latter occurs with slight variants among all the Latin and Teutonic and even Slavonic nations; it is represented among the French by Carpe, the Dutch by Karper, the Germans by Karpfe, and the Russians by Carpa. These seem to be derivatives of a southeast European word and the earliest reference to it occurs in Cassiodorus, who wrote about 575; he refers to it as a fish of the Danube ("destinet carpam Danubius").

The carp is by far the most important of the Cyprinids and its range has been extended much beyond its natural habitat by the favor or industry of man. This extension commenced early and it was planted in many European waters at various times. It has been supposed that its introduction into England was effected after the discovery of America. Many may remember that father Walton (1653) wrote that "there doubtless was a time about a hundred or a few more years ago, when there were no Carps in England,

as may seem to be affirmed by Sir Richard Baker, in whose Chronicle you may find these verses:

> Hops and turkies, carps and beer,
> Came into England all in a year.

The distich has no foundation in fact; the earliest known reference to the carp occurs in Dame Berners' "Boke," published in 1496.

The first successful introduction of the carp into America was made in 1877 when Rudolph Hessel brought three hundred and forty-five fishes for the United States Fish Commission. These were released into breeding ponds and in 1879 distribution of their young was made and continued for many years afterwards. Now the species is thoroughly naturalized and widely distributed throughout the United States. It has become a regular market fish and is by many held in considerable esteem, but there is also much prejudice against it. Expressions of opinion as to the merits of the fish were collected by the United States Fish Commission a few years after its introduction and published in its Annual Report for 1884 (pp. 659–890). The range of opinion among the two hundred and forty-two answering was not less remarkable than some of the modes of expression.

A belief that male frogs and toads, driven by urgent sexual passion, will leap upon a carp's head and remain there for some time has been long entertained. Izaak Walton was told of a pond being drawn and that *every* carp left in it had "a frog sticking so fast on the head of the said carps, that the frog would not get off without extreme force or killing." The excellent Walton was overcredulous and such a statement (which has been ridiculed) would not deserve consideration if it rested on his belief only, but a very eminent naturalist has lent his own high authority to an analogous statement. Smitt, in his magnificent work on Scandinavian fishes, also tells that "carp are often troubled by the male frogs, which under the influence of sexual excitement attach themselves firmly to the head of the sluggish carp, and with their forefeet press the eyes of the fish so hard as to produce blindness."

Incredible as the frequent occurrence of such assaults may appear, Smitt had sufficient reason for his statement in data published by reputable eye witnesses. In 1870 (April 11), M. Duchemin presented to the Academy of Sciences of France a report on some cases that he and M. Deroche had observed. In a large pond numerous carp live and thrive except in early spring when, every year, "an extraordinary mortality occurs among them." Every dead fish was

found to be blind, a kind of film covering the eyes and even part of the head. After much investigation, the gentlemen named were convinced that the mortality was caused by a toad (*Bufo calamita*). "They examined all the carp in the pond, and found squatting on the head of each of those that were diseased an enormous toad, the fore-paws of which were placed on the two eyes of the unfortunate fish. Thus, this ugly batrachian, which presents so stupid an aspect, has yet sufficient intelligence to assume the offensive and to overcome a large fish. It has not agility and energy, but it has cunning and perseverance. It would appear to kill by exhaustion, but it remains to be ascertained whether the acrid secretion of the skin assists in the conquest."

Such assaults on a fish are the more remarkable on account of the specialized manner in which male frogs and toads connect with and grasp the females. The manner in which they do this is so characteristic that it has been utilized by some herpetologists for the classification of the order to which they belong. The toads, for example, grasp the female around the body just behind the forelegs and the *Bufo calamita* has what is called a pectoral amplexation.

The carp readily interbreeds with the goldfish (*Carassius auratus*), or rather with its very close poor relation, the karass (*Carassius carassius*); the hybrid has intermediate characters so distinct from each parent that it was formerly considered to be a distinct generic type and named *Carpio kollarii*. Hessel succeeded in getting young from (1) a female carp and male karass, as well as from (2) a female karass and a male carp, and all had the characteristics of *Carpio kollarii*. He also found that hybrids were fertile, for he obtained hybrids of the second degree from an original female hybrid (*Carpio kollarii* and a male carp; this was distinguishable "with difficulty" from "the genuine carp." On application to the palate, however, judgment was pronounced that the "flesh was exceedingly poor and bony." (It could have been bony only so far as leanness and deficiency of flesh to cover the bones were involved, for the number of bones must have been the same in the two fishes.)

The latest use found for the carp is an eradicator of the trematode worm which is the cause of the fluke-disease so prevalent in some regions. Doctor Stiles, in 1902, published testimony to the effect that, since carp had been introduced into Oregon and Washington the disease (*distomatosis* or *fascioliasis*) had been very much reduced and the reduction was attributed to the agency of the carp

which devour the young worms in the cystic stages as well as the snails (Limnæids) in which they pass part of their lives.

Other Noteworthy Cyprinids

The Goldfish (*Carassius auratus*) has been still more extensively diffused throughout the world than the carp. It is of a genus (*Carassius*) distinguished from the carp by the absence of barbels and the development of only one row of pharyngeal teeth. The type of the genus is the karass, or crucian carp, and the generic name is latinized from the popular one. Closely related to the karass is the goldfish, which originally was of Chinese origin and in China (where it is widely known as the Ken-ju) for unknown time it has been the object of culture and innumerable varieties have been bred. (Savigny, in 1780, gave colored illustrations of eighty-nine varieties.) It is generally maintained that it was introduced into continental Europe about the early part of the eighteenth century, although it may have found its way there long before. Anyway, it was not until the eighteenth century that the fish became common and much cultivated; about 1730 it was introduced into England, and from England is was diffused among the continentals. It was early brought to the United States. In Europe and the United States, wherever the climate is not too rigorous, the species has been acclimatized and in the United States may be caught near almost every large city in some pond or other. Many of the variations to which the fish has been subject are of the nature of monstrosities, such as the double, triple or greatly extended caudal fin, the finless back, and the "telescopic eyes."

The Tench (*Tinca tinca*) is recognizable by its very small scales, deeply embedded in the smooth and slippery skin, which remind one of an eel's. The fins are rounded rather than angulate as in most of its relatives, and the males are peculiar in the development of much thickened and flattened outer rays to the ventral fins, the females having ordinary rays. Sexual differentiation extends even to the pelvic bones.[1] The species sometimes attains a weight of three or four pounds or occasionally even more. It prefers still and rather warm waters with a muddy bottom and abundant vegetation. In a natural condition it lives near the bottom and "is always working in the mud." It has been much cultivated in ponds

[1] The remarkable sexual differentiation manifest in the pelvic bones as well as ventral fins of the Tench was fully noticed and illustrated by Dr. Günther in the *Annals and Magazine of Natural History* (III, 385–387, 1859). The plate is reproduced for this article.

and several varieties have been originated, one of which is the golden tench. Its introduction into the United States was effected many years ago but it has not been extensively distributed like the carp.

Some curious myths have originated about the tench.

Walton commenced his chapter on the fish with the assertion that "the tench, the physician of fishes, is observed to love ponds better than rivers"; he says that it is the physician "for the pike especially, and that the pike, being either sick or hurt, is cured by the touch of the tench," and that the pike "forbears to devour him though he be never so hungry." (Some anglers nowadays say that "you cannot put a better bait on a trimmer than a young tench. Trout will also eat tench." In the stomach of one trout twenty-two small tenches were found.) Nevertheless Carbonnier tells us that in France it is to this day called "fish-doctor" and that "tench are often placed in tubs with other fish which manifest signs of sickness, whereupon the tench, occupying the bottom of the tank, force the sick fish from their state of inactivity, and compel them to circulate freely through the water, an exercise which of itself often proves beneficial. Healing properties are also attributed to the mucus which flows freely from the skin."

Not only was the tench supposed to be a physician of fishes; it was of use to man himself. Walton reports that "Rondeletius says, that at his being at Rome, he saw a great cure done by applying a tench to the feet of a very sick man," and gives a long account of it. Now Rondeletius (or rather Rondelet) was a good ichthyologist as well as physician, for his time, and if he believed in such an unsubstantial "fact" it is not to be wondered that Walton did.

Again Walton repeats that "in every tench's head there are two little stones which foreign physicians make great use of." These two stones are the otolites or ear-bones which occur alike in all the fishes of the same family as well as in almost all other true fishes.

There may be some basis for the belief that most other fishes leave the tench alone. Perhaps the best evidence known has been given by J. G. Odelly (1868). He took from an overstocked tank "three or four carp and an equal number of tench and put them into another tank containing stickebacks. Almost immediately after they were put there the sticklebacks set upon the carp and gave them no rest till they died," three or four days later, when no "vestige of fin and tail were left." The tenches, however, were "not molested at all" and remained with the sticklebacks, "appar-

ently happy and comfortable." Their immunity may be due to superficial secretions which are disagreeable to other fishes.

Tench is a name derived from the old Latin *Tinca* which has developed into Tenca in modern Italy and Tanche in France. The Teutonic nations have very different words, Schleihe or Schley being the most common in Germany, Qeelt in Holland, and Lindaren in Sweden. No traces of cognate names have been found in Britain. The scientific equivalent is *Tinca tinca* or *vulgaris*. The chief characteristics, as already indicated, are the small, thin, closely-adherent scales, and also the peculiar dark color.

The GUDGEON (*Gobio gobio*) is a neat, symmetrical fish with the dorsal fin about its middle over the ventrals, and with a conspicuous barbel at each side of the mouth. It is gregarious and mostly keeps near the bottom. "To the fisherman living on the banks of the Thames the gudgeon is one of the most valuable of British fishes, inasmuch as fishing for the brave little fellow, which gives such excellent sport, is an excuse for many a pleasant outing." It is the chief fish of the order in the Seine near Paris.

Gudgeon is a name derived from the French Goujon; the German name is Gründling and the Dutch equivalent is Grondell. No congener of the gudgeon is found in America.

The BARBEL of northern Europe (*Barbus barbus*) is the type of a genus of very numerous species peculiar to the Old World, represented by many forms in Asia, especially in its southeastern regions, and about sixty in Africa. The name is cognate with those occurring in other countries and in the thirteenth century the same form was prevalent in France, but now Barbeau is the French name, Barbe the German, and Barbeel the Dutch. Barbel is a derivative of the late Latin *Barbellus,* a diminutive of the old name *Barbus.* The four barbels or barbs on the sides of the upper jaw (two on each side) are the distinctive characteristics of the common barbel but are not manifest in all the species of the genus.

The collective characters of all the species are the three rows of pharyngeal teeth, as already indicated, which are cylindrical, hooked and excavated at the base of the crown, and there is also a general conformity in the head, course of the lateral line, and size of the fins. As might naturally be expected in such an enormous group, the variation otherwise is very great; in length they range from little more than an inch to five or six feet; in weight, from an ounce to nearly if not over a hundred pounds;[1] although four barbels

[1] A much greater weight has been claimed for one of the species of *Barbus.* Dr. Günther in 1868 (Catalogue, VII, 86) says unqualifiedly of the *Barbus eso-*

are generally developed, many have only two and not a few have none; in the size of the scales there are the extremes of at least eighty and twenty transverse rows. Some of the other features in which species differ may be known from the differential characters of three specially noteworthy ones representing different sections of the genus. All of these have two pairs of barbels.

According to Professor Max Weber, a South African barbel, described in 1897 (*Barbus viviparus*) is viviparous!

The common barbel of Europe (*Barbus barbus*) is representative of a group characteristic of Europe and Asia Minor, distinguished by a strong and coarsely serrated dorsal spine, five branched anal rays, and small or moderate scales; specifically, it has about sixty (54–63) scales along the lateral line and there are about seven (7) rows between the lateral line and ventral fin; the snout is very prominent and the lips are regularly thick.

The barbel is an outlier of an immense aggregate of tropical and subtropical species and as such prefers warm water and does not ascend as far north as most of the European Cyprinids; it is not a tenant of the Scandinavian streams for instance.

It furnishes very poor food, although it is a favorite angler's fish. Captain Buckland thought that "a good day's barbel fishing is enjoyable beyond all measure, but it is most advisable to employ a professional fisherman to ground-bait the 'swim,' arrange the tackle, etc."

All the preceding species except the barbels belong to the typical subfamily, *Cyprinines,* distinguished by the triangular and very hard carp-stone or mill-stone, very short anal fin, and lateral line median along the tail. Most of the European species belong to another subfamily (Leuciscines) which have a pentagonal or irregular and elastic pharyngeal carp-stone and moderately short anal, the lateral line being median on the tail as in the carps. Many of the best known of the European fishes belong to it and are the delight not only of the youthful angler, but of numerous men who know not the joy of contest with fishes of nobler kind or have not the means of reaching such. The familiar names chub, dace, minnow and roach are given to members of the subfamily. These names have been so much misapplied and are so interesting themselves that an

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cinus, a fish of the "river Tigris, near Mossul," that it "attains to a weight of 300 pounds," but this statement is not corroborated, so far as known, by any other author or by Dr. Günther himself in his later writings. The original describer's (Heckel's) largest specimen was only two feet and a quarter long. ("Die Exemplare unseres Museums sind 2 Zoll bis 2 Schuh 3 Zoll lang.")

account of the original uses of the names and of the fishes to which they were given may be welcome.

The chub, roach, dace, rudd, ide and minnow of Europe are quite closely related to each other and by some ichthyologists are united in a single genus (*Leuciscus*), although by others they are isolated in as many genera as there are names.

The CHUB, or cheven (*Leuciscus cephalus*), is a rather large and thick-headed fish with the dorsal fin somewhat arched and not emarginated as in most of its congeners. Its average length is less than a foot, though sometimes much greater; its weight about a pound. It is a restless fish which "lives almost entirely near the surface of the water"; it is because it does so, according to Carbonnier, that it does not contract that taste of mud which characterizes fish which live at the bottom," and consequently of all the European Cyprinids it is by him esteemed to be "one of the best for eating." "In most hot days," according to Izaak Walton, "you will find a dozen or twenty chevens floating near the top of the water." It was this habit that enabled "Piscator" to see the biggest of the school of chubs when he had approached the brook with Venator and to identify it by the "bruise upon his tail" which looked "like a white spot"; it was caught, it will be remembered, as Piscator promised, and Venator had received his first lesson.

The chub is unique in bearing a name which is entirely isolated from all by which the fish is known in other lands. Its etymology and history are quite obscure, although much attention and speculation have been spent on it, and its earliest known recorded use is in the celebrated Book of St. Albans (1496). It evidently is connected with the same word which has given us "chubby" and has reference to the form of the fish and especially its head.

The chub, besides being the first fish which Piscator Walton taught his pupil Venator to catch, was also an object lesson as to how it might be so managed that, though by some "reckoned to be the worst of fish," it might be made "a good fish by dressing it."

The chub has been claimed by a recent writer (Buckland) to be "remarkable for his hawk-like quickness of sight; even the shadow of the rod or a passing cloud will make him sink instantly." Yet Piscator selected it for his first lesson in angling because he thought "there is no fish better to enter a young angler, he is so easily caught." The Frenchman's opinion as to the chub's sapidity also may be contrasted with that voiced by "Venator" and half endorsed by "Piscator." "A chub is the worst fish that swims," expostulated "Venator," and only by cooking could the fact be disguised

by "Piscator." It is indeed good cooking that makes any Cyprinid palatable!

The DACE (*Leuciscus leuciscus*) is closely related to the chub but is conspicuous for its shiny, silvery appearance, which renders it a favorite lure for the pike. Its average length is about eight or nine inches. It affects clear streams and rather deep water with a gravelly bottom. It is a very lively and active fish and its frequent dart-like movements, it has been claimed, have suggested the names dard and dart. Dace (also rarely spelled Dase and Darce) is perhaps a curtailed derivative of the French Vandoise or its original, and Dart as well as Dort of the French Dard. Vandoise is now the most prevalent name in France, Dart being more restricted. The most current German name is Louben.

The ROACH (*Rutilus rutilus*) is one of the most esteemed angle fishes of Europe and a special " Book of the Roach " has been published for the benefit of anglers. At one time, as by Walton, it was " accounted the water-sheep, for his simplicity or foolishness." But many now are convinced, with Frank Buckland, that " to catch him the fisherman must have a subtle eye and a steady hand." It sometimes attains a weight of two pounds or even more, but that is very much above the average.

It thrives in stagnant water and muddy ponds and is the most common fish in the river (Lea) which Walton often fished.

The RUDD (*Scardinius erythrophthalmus*) is distinguished by its high back, reddish fins, and red eyes. It occurs in such localities as the roach affects, but is less generally distributed. According to Day, " It has been asserted that where Rudd exist roach are almost invariably present, whereas the converse does not hold good." It rarely attains a length of two pounds, and is " scarcely eatable."

The name is supposed to be connected with red and ruddy. Red-eye is another (rare) English name of the fish and parallels the German Rothauge.

The MINNOW (*Phoxinus phoxinus*) is the smallest of the Western European Cyprinids, has small scales, and is at once distinguished by the incompleteness of the lateral line. It is usually found about three or four inches long. The males develop tubercles on the head and are brightly colored during the breeding season.

The present name was preceded, in the usage of our predecessors by such forms as menow, mine, and the like, and has been supposed to be " possibly from the root of min, less, with *me* termination -ow due to the confusion with some other word, perhaps *of,* menu

(thus the Century Dictionary indicates) small. cf. *me.* Menuse, small fish." More facts are wanted.

Many fishes, really very close to the Leuciscines but with a longer anal fin, have been segregated from the latter because of that character and named the Abramidines. Different as are the extremes of the two groups, they grade into each other.

The BREAM (*Abramis brama*) is characterized as well by its deep and compressed body as by the long anal fin. It is a fish of considerable size and one recorded by Buckland measured two feet two inches in length and weighed nearly twelve ($11\frac{3}{4}$) pounds. The name is cognate with the French Bréme, while the German name is Brachsen or Blei. There are a number of species in the continental waters more or less related to the bream. The nearest relation to it in America is the common silver fish or golden shiner (*Abramis* (or *Notemigonus*) *chrysoleucas*).

It spawns in June about Paris and the male and female keep on the surface of the water at spawning time, moving and rubbing themselves one against the other. They then proceed to the emission and fecundation of eggs, which burst out in all directions and are disseminated on all sides.

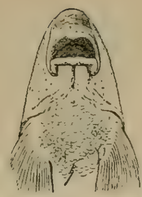
Such are the fishes truly entitled to the names that have been used for them. The fishes themselves are sufficiently common and conspicuous to become to some extent familiar to the sport-loving Englishmen, and the early emigrants from England took the names with them to the new world; the old names were given to the new fishes found in their adopted homes. Often they were very much misapplied and the American species called by the familiar names are frequently extremely different. Carp was appropriated for a Catostomid (*Carpiodes*); roach was devolved on a sunfish (*Eupomotis gibbosus*) which is more like the English perch; chub was used for a relative of the sunfish (black-bass) in one colony and in another for a kind of sucker which belongs to a family (Catastomids) not found at all in England; minnow is largely used for small species of an unrelated family (Pœciliids); tench was attached in Carolina to the salt-water labrid now generally known as the tautog or blackfish (*Tautoga onitis*); barbel was applied in some regions to the American suckers (*Catostomus*). None of the fishes so misnamed belong to or very near the family of the real owners of the names.

Fewer of such names were transferred to Australian fishes, mostly no doubt on account of the poverty of the fresh-water fauna of the southern continent. Bream, however, is given to half a dozen

species at least; in most cases to sea fishes of the family of Sparids from a supposed resemblance to the sea bream of England (*Sparus auratus*), but also to a couple of fresh-water fishes with a superficial likeness to the *Abramis;* the fresh-water fishes are mostly of the family of Dorosomids (*Dorosoma richardsonii*), related to the hickory shad of the United States; a perch-like fish of the family of Theraponids, called also silver perch (*Therapon richardsonii*), also bears the name of bream. Carp is equally misapplied, being forced on an excellent marine food fish of the perciform family of Chilodactylids.

One of the old English names (Barbel) has been singularly, though not inaptly, applied in South Africa to a Silurid (*Clarias garicpinus*), which indeed has barbels, and long ones too, but is not at all related to the real English barbel, and yet a number of Cyprinids congeneric with the true barbel are inhabitants of South African streams.

The misapplication of these names to some American Cyprinids will be considered in a subsequent article.



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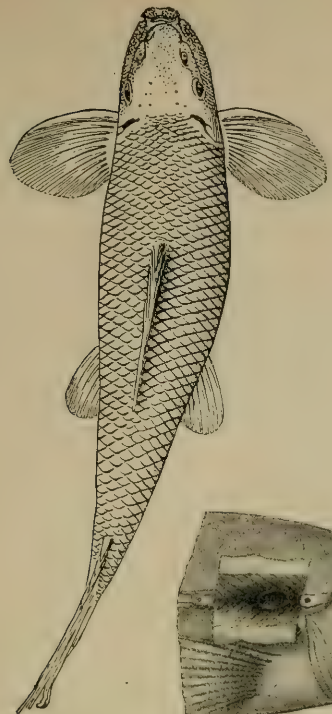

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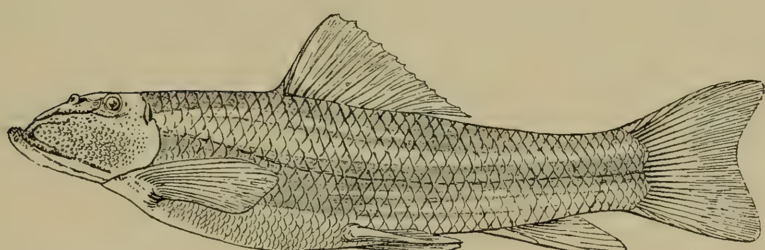

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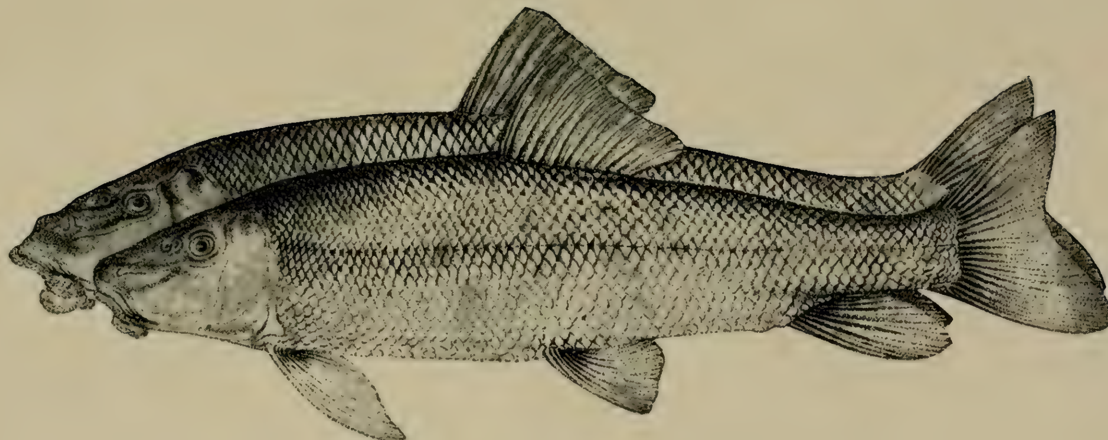
1. *Gyrinochilus,* rom above. 2. *Gyrinochilus,* lateral view. 3. *Gyrinochilus,* mouth. 4. *Homaloptera ocellata,* from below. 5. *Homaloptera ocellata,* lateral view. 6. *Nemachilus barbatula,* head and thoracic region to show the double subcutaneous aperture of the air bladder.



COMMON SUCKER

(*Catostomus commersonii*). After Lesueur.

PLATE XLVII

(*After Owen.*)

FIG. 1. Carp's head with operculum cut away to show pharyngeal bones and carpstone.

2. Pharynx of a Carp open from below, with the two pharyngeal bones divaricated. *a,* occipital pharyngeal plate or carpstone; *b,* part of a cell in the fleshy pharynx cut open, to show *c,* the germ of a pharyngeal tooth. The small upper figure shows the basal pulp-cavity of a large pharyngeal tooth.

3. Pharynx of a Tench open from below, with the two pharyngeal bones divaricated.

4. Pharyngeal teeth, *in situ,* of a Barbel (*Barbus barbus*).

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PHARYNGEAL TEETH OF CARP, TENCH AND BARBEL (AFTER OWEN)

PLATE XLVIII

Pharyngeal bones of chief European Cyprinoid genera according to Fatio.

FIG. 1. *Cyprinus carpio.* Carp.

2. *Tinca tinca.* Tench.

3. *Tinca tinca.* Tench. Right pharyngeal with the abnormal number of 5 teeth and 2 young replacing teeth at the roots.

4. *Gobio gobio.* Gudgeon.

5. *Barbus barbus.* Barbel.

6. *Rhodeus amarus.* Bitterling.

7. Hybrid between *Scardinius* and *Abramis.*

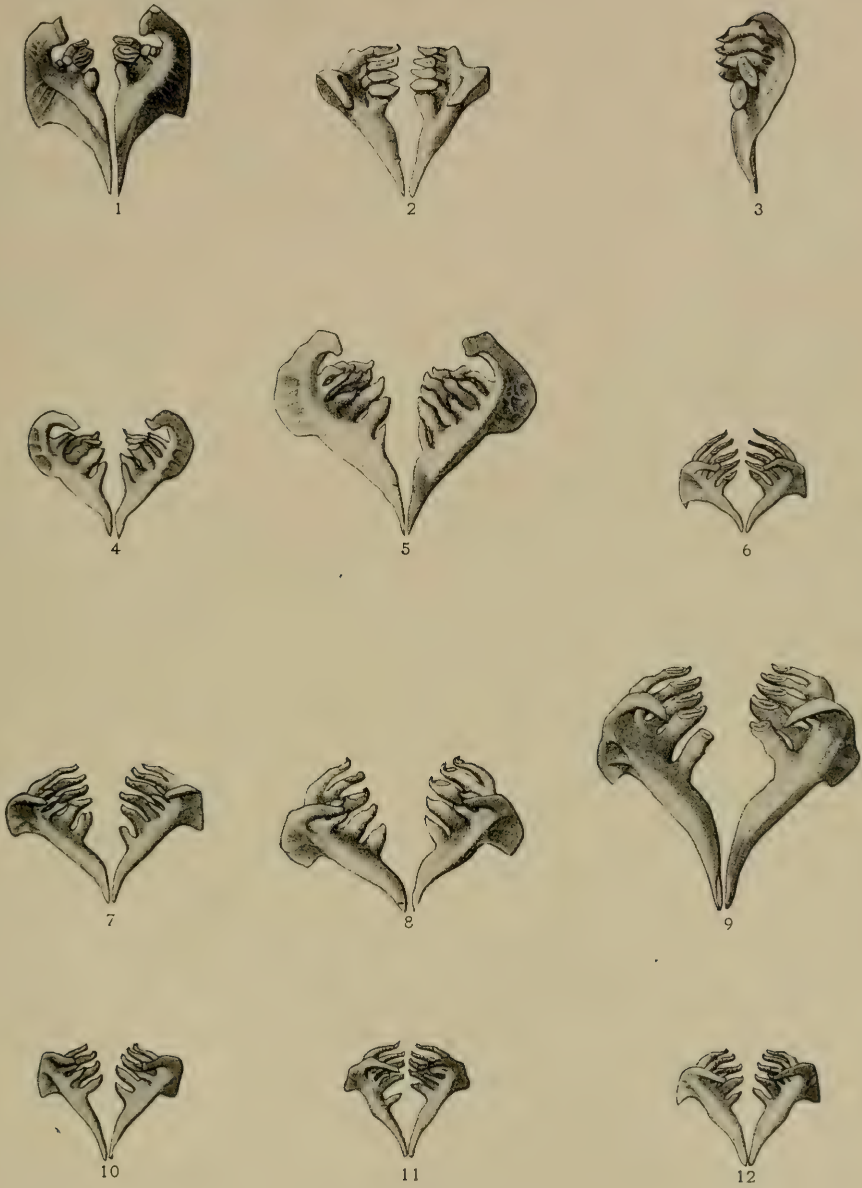
8. *Abramis brama.* Bream.

9. *Abramis (Blicca) bjoerkna.*

10. *Spirlinus bipunctatus.*

11. *Alburnus alburnus.* Bleak (variety).

12. *Alburnus alburnus.* Bleak.



PHARYNGALS (After Fatio)

PLATE XLIX

(*After Fatio.*)

FIG. 1. *Scardinius erythrophthalmus.* Red eye.
2. *Rutilus rutilus.* Rudd.
3. *Rutilus aula.*
4. *Rutilus pigus.*
5. *Leuciscus cavedanus.*
6. *Leuciscus leuciscus.*
7. *Leuciscus agassizii.*
8. *Phoxinus phoxinus.* Minnow.
9. *Chondrostoma nasus.*
10. Hybrid between *Leuciscus cephalus* and *Chondrostoma nasus.*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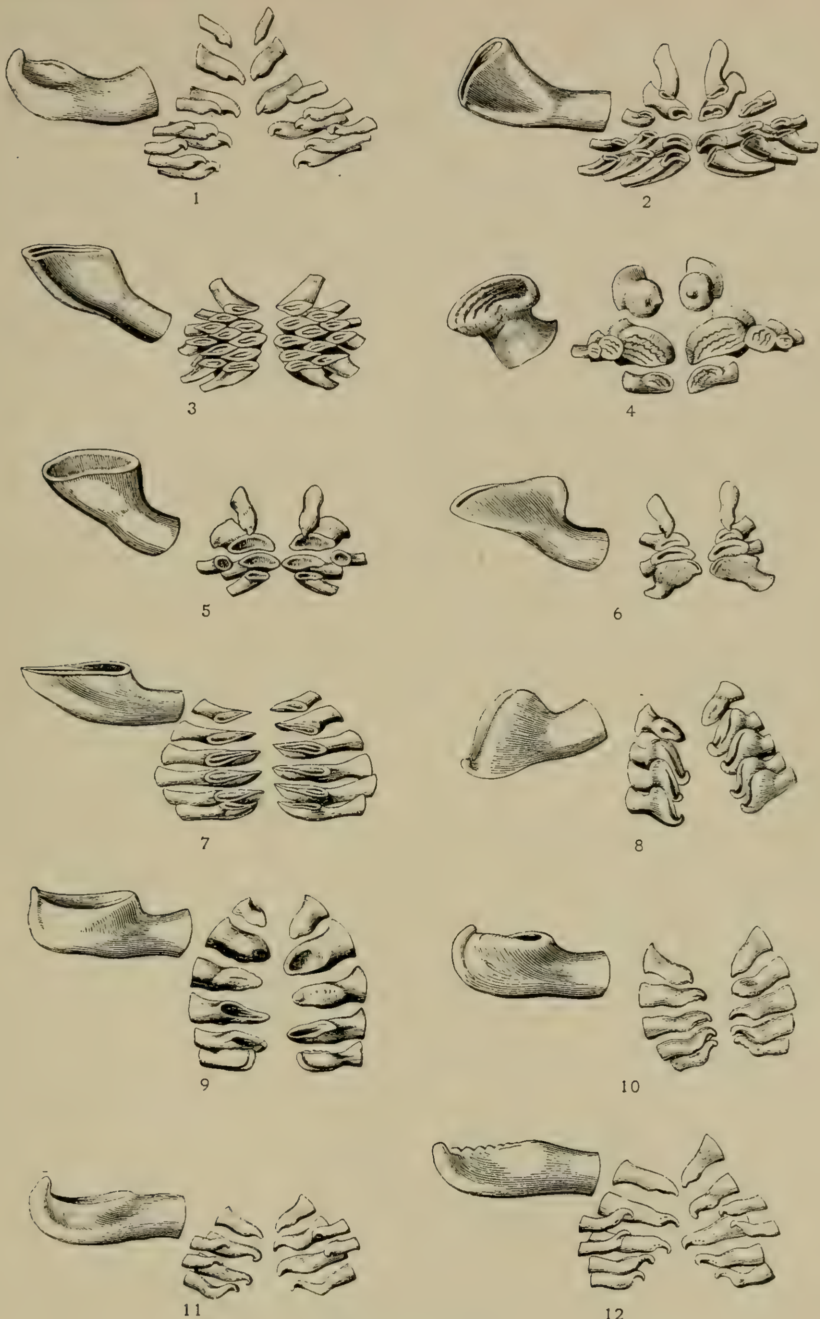
PHARYNGALS (After Fatio)

PLATE L

Teeth of Cyprinoid genera according to Heckel.

FIG. 1. *Barbus barbus.* Barbel.
2. *Capoeta damascina.*
3. *Labeo niloticus.*
4. *Cyprinus carpio.* Carp.
5. Hybrid between Carp and Karass.
6. *Carassius carassius.* Carass (Karausche).
7. *Chondrostoma nasus.*
8. *Tinca tinca.* Tench.
9. *Rutilus rutilus.* Roach.
10. *Abramis brama.* Bream.
11. *Notropis cornutus.* Redfin.
12. *Leuciscus dobula.* Chub.



TEETH (AFTER HECKEL)

PLATE LI

1–6, teeth of Cyprinoid genera according to Heckel.

FIG. 1. *Scardinius erythrophthalmus.* Red eye.
2. *Idus idus.* Ide.
3. *Aspius aspius.* Asp.
4. *Gobio gobio.* Gudgeon.
5. *Danio alburnus.*
6. *Catostomus commersonii.* Sucker.
7. *Nemachilus barbatulus.* After Fatio.
8. *Nemachilus barbatulus.* Side view. After Fatio.

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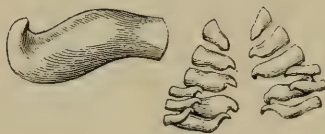

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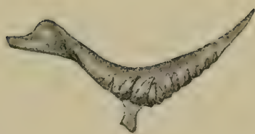

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PHARYNGEAL TEETH

Plate LII

Carp stones of various European species showing free surfaces and profiles according to Fatio.

Figs. 1, 2. *Cyprinus carpio.* Carp.
3, 4. *Tinca tinca.* Tench.
5. *Barbus barbus.* Barbel.
6, 7, 8. *Gobio gobio.* Gudgeon.
9, 10, 11. *Rhodeus amarus.* Bitterling.
12, 13. *Abramis brama.* Bream.
14, 15. *Abramis (Blicca) bjoerkna.*
16, 17. Hybrid between *Scardinus erythrophthalmus* and *Blicca bjoerkna.*
18, 19. *Spirlinus bipunctatus.*
20, 33. *Alburnus lucidus.* Bleak.
21, 22. *Alburnus lucidus.* Bleak variety.
23, 24. *Scardinus erythrophthalmus.* Red eye.
25, 26. *Rutilus rutilus.* Roach.
27, 28. *Rutilus pigus.*
29, 30. *Rutilus aula.*
31, 32. *Leuciscus cephalus.* Chub.
34. *Leuciscus leuciscus.*
35, 36. *Phoxinus phoxinus.* Minnow.
37, 38. *Chondrostoma nasus.*
39, 40. Hybrid between *Leuciscus cephalus* and *Chondrostoma nasus.*

CARPSTONES (After Fatio)

PLATE LIII

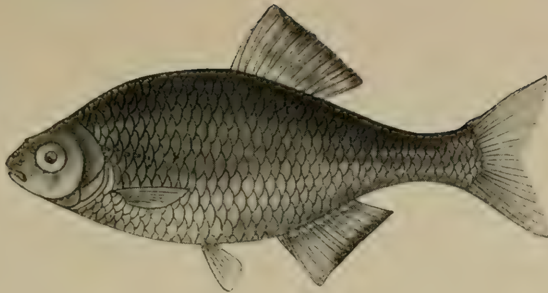
FIG. 1. The Bitterling (*Rhodeus amarus*). Male in breeding season.—After Siebold.

2. The Bitterling (*Rhodeus amarus*). Female with long ovipositor.—After Siebold.

3. Section of Mussel gill with embryoes of Bitterling intervening between lamellæ.

4. Abdomen of female Bitterling. *o,* ovary; *t,* anterior extension of ovary; *l,* line free from follicles; *ov,* oviduct; *AA,* glands; *R,* oviducal tube; *M,* mesoarium; *S,* swim-bladder; *P,* pneumatic duct between air-bladder and stomach; *D,* intestinal canal.—After Olt.

5. Mussel showing gill and directions of water currents. *a,* course of branchial flow; *b,* meeting place of currents from branchiæ; *c,* inhalent respiratory current; *d,* exhalent current; *e,* mouth.



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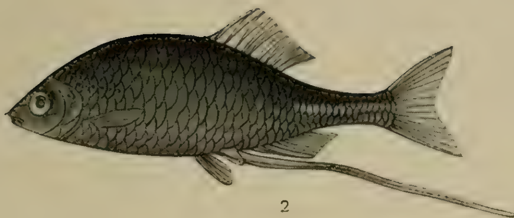

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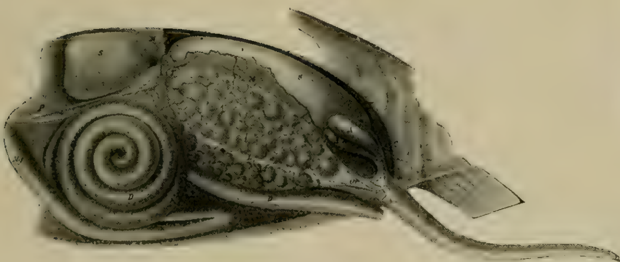

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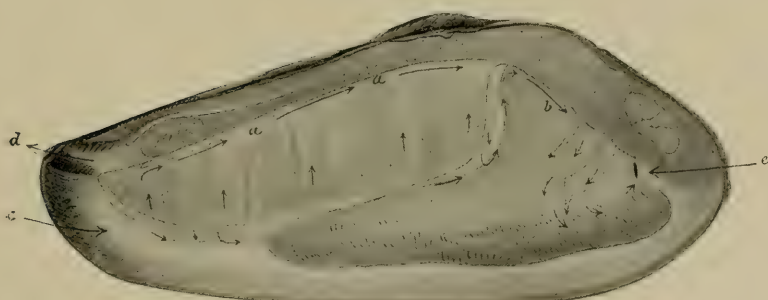

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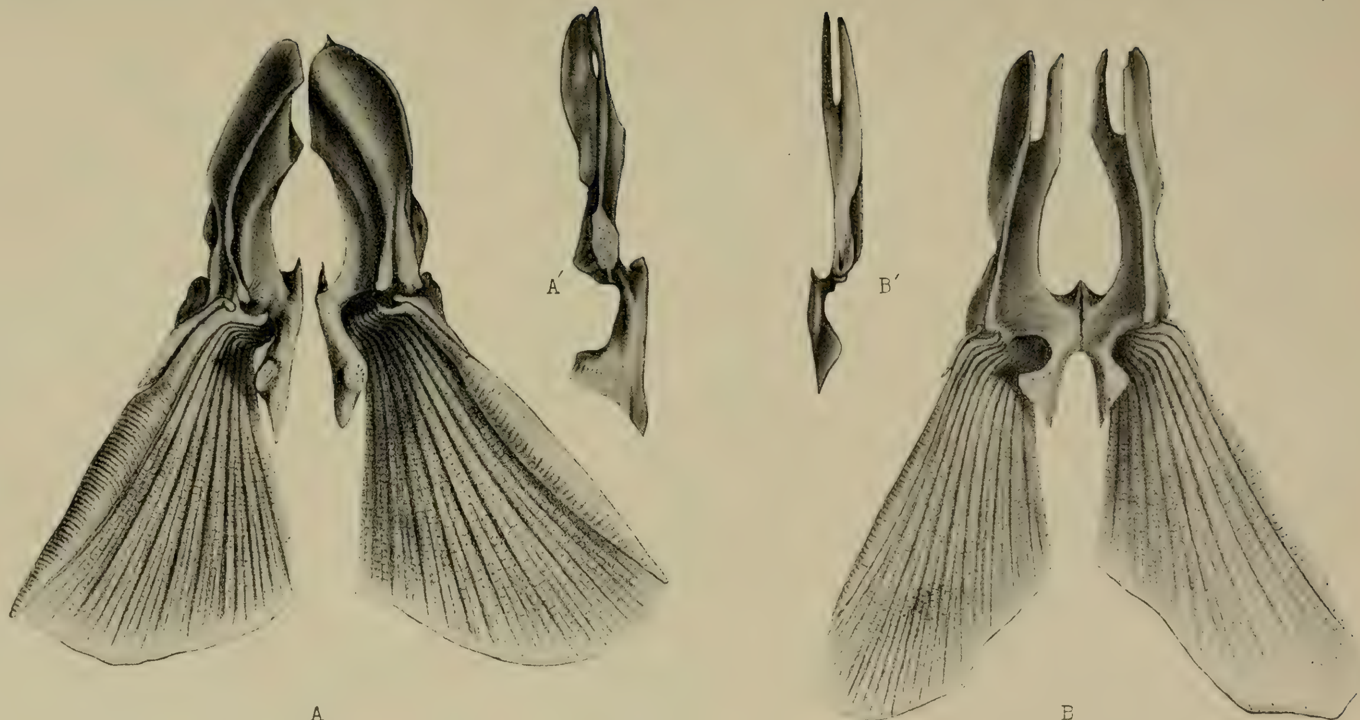
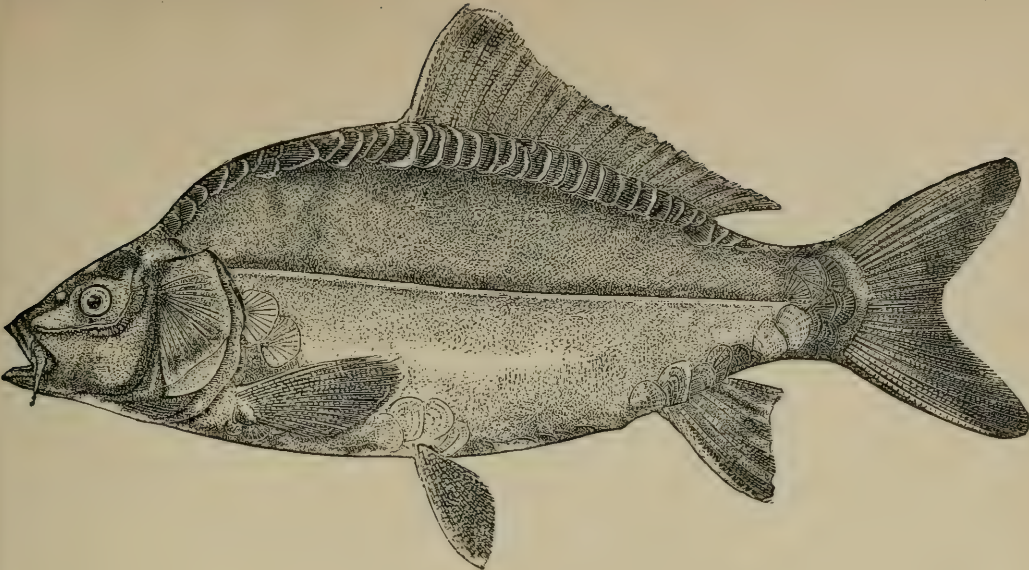
SEXUAL DIFFERENTIATION OF THE BITTERLING



SEXUAL PECULIARITIES OF TENCH

A. Male. *B*. Female. (After Günther.)



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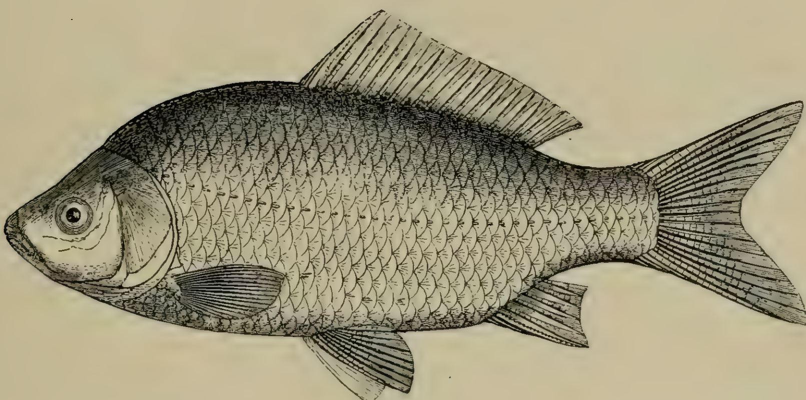

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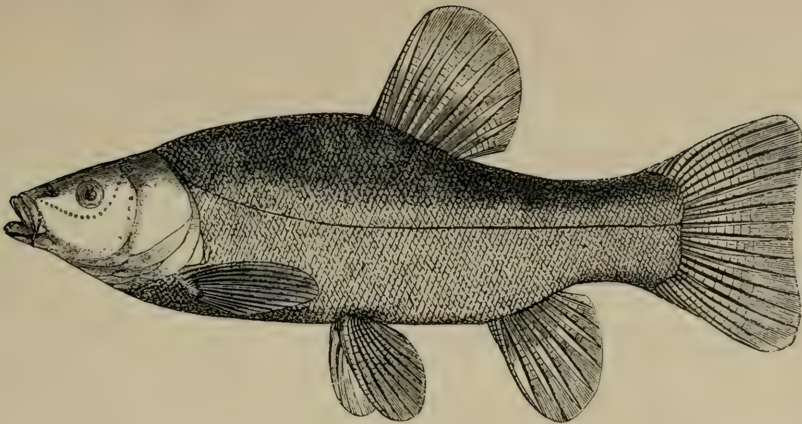
1. CARP. 2. HYBRID BETWEEN CARP AND CARASS OR GOLDFISH. 3. GOLDFISH



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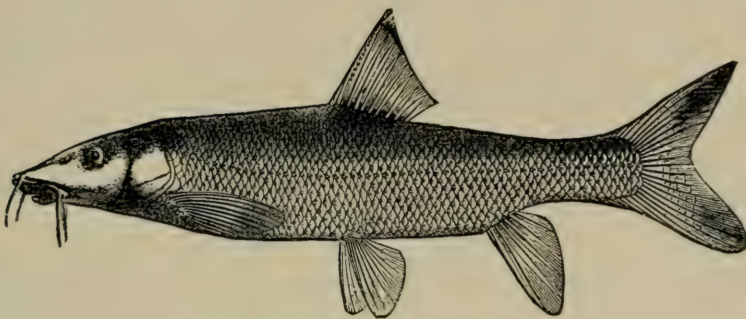

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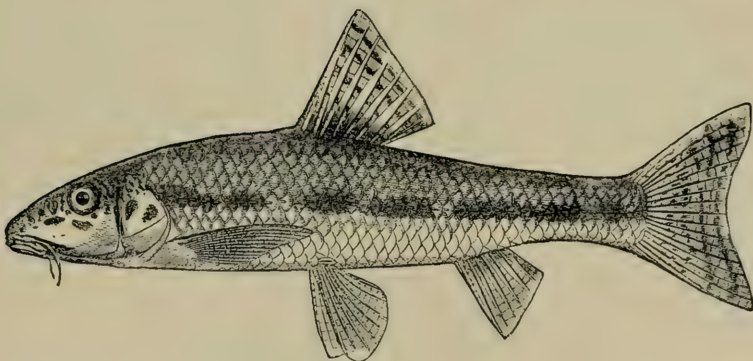

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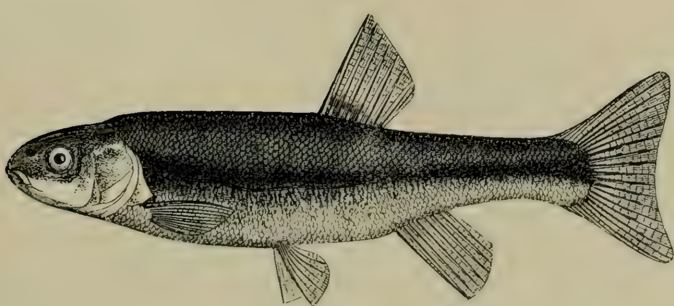

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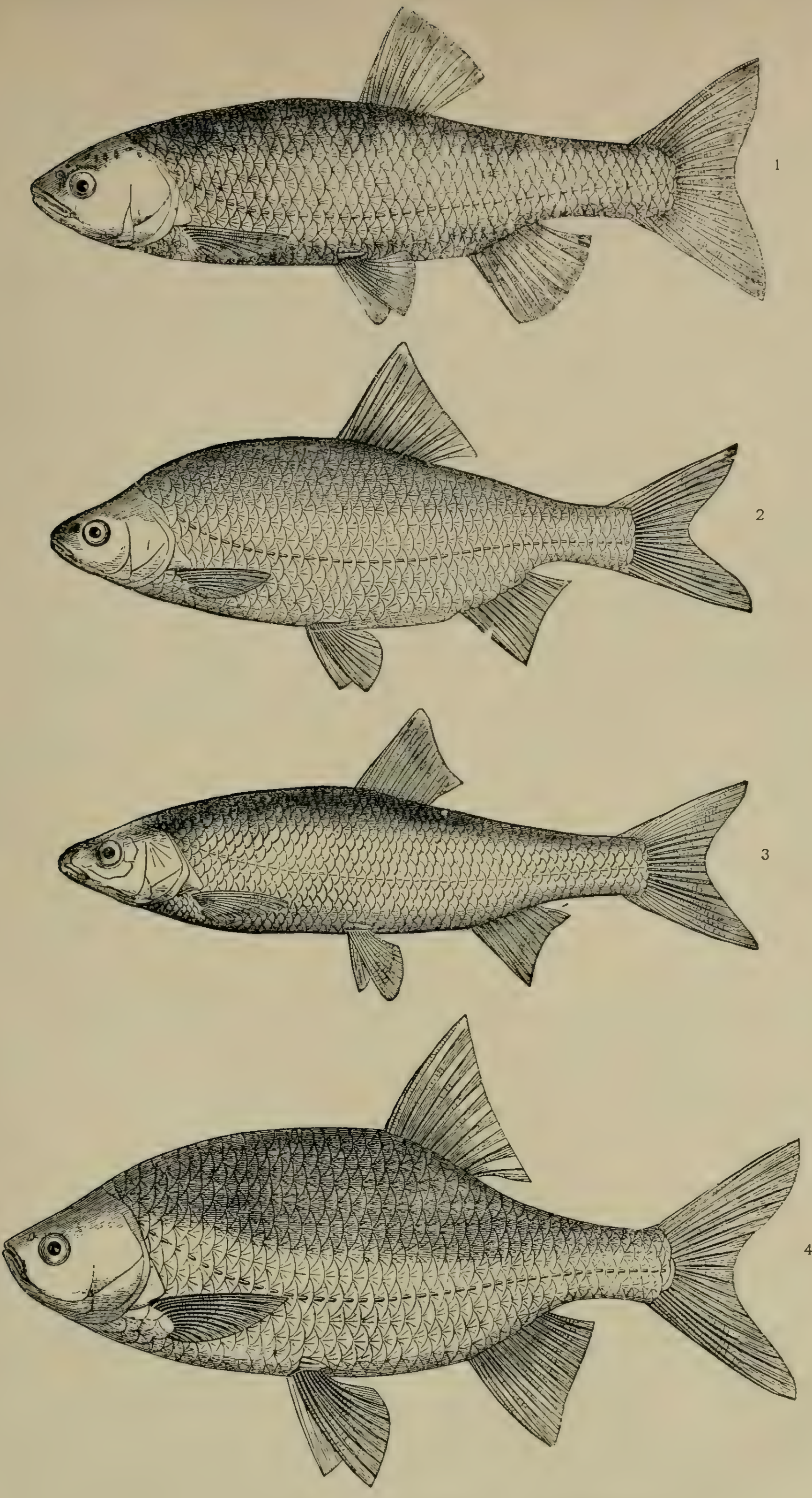
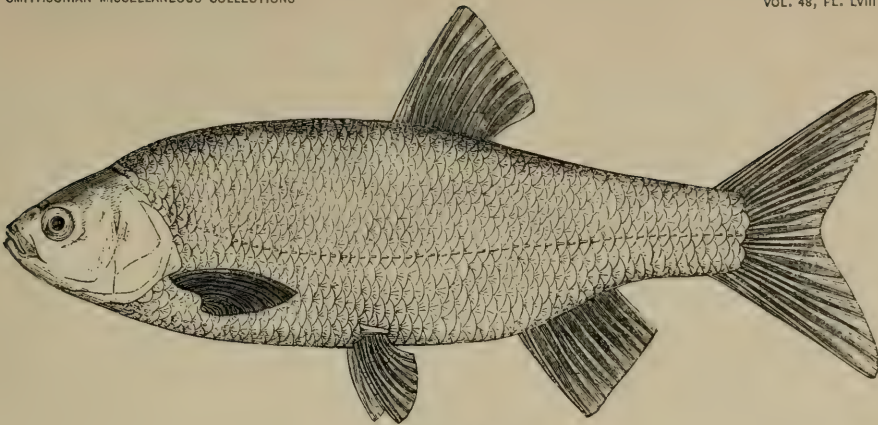
1. TENCH. 2. BARBEL. 3. GUDGEON. 4. MINNOW. (AFTER HECKEL AND KNER.)



1. CHUB. 2. ROACH. 3. DACE. 4. RUDD. (AFTER HECKEL AND KNER.)



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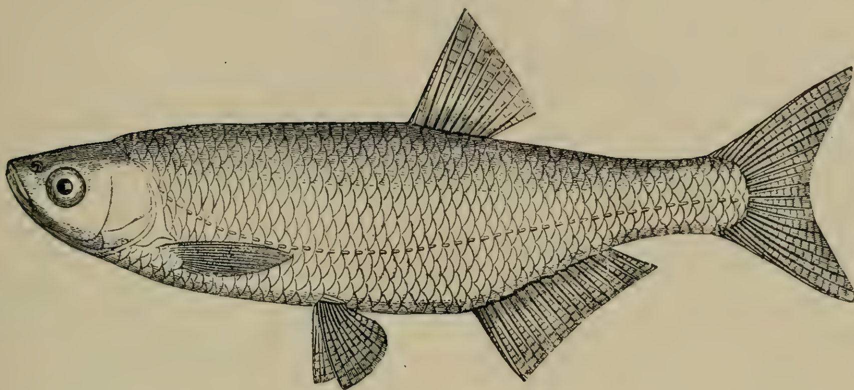

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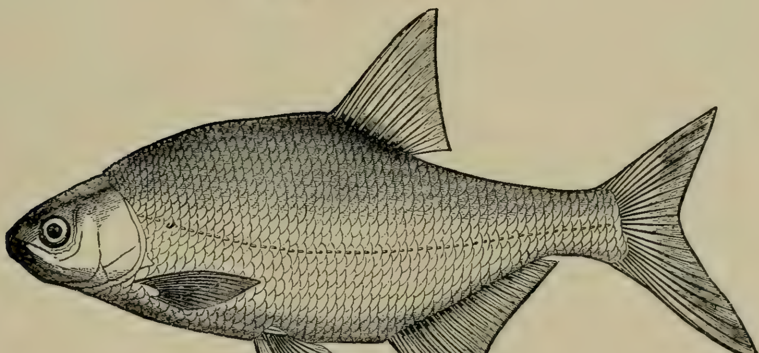

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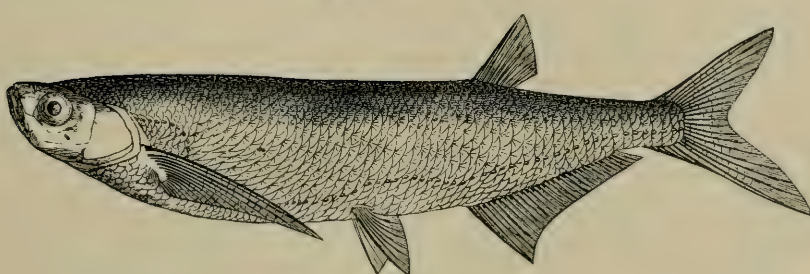

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1. IDE. 2. BLEAK. 3. BREAM. 4. SICHLING. (AFTER HECKEL AND KNER.)

THE INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE[1]

By CYRUS ADLER

Since presenting an account of the work of the International Catalogue of Scientific Literature at the first general meeting of the American Philosophical Society thirty-nine volumes have been published and distributed to the subscribers in the United States; that is to say all of the First Annual Issue for 1901, all of the Second Annual Issue, excepting the volumes of zoology, and four volumes of the Third Annual Issue, these constituting a classified index to all original contributions made in all parts of the world to practically all of the pure sciences. Now that the work is well under way a critical examination is possible to determine whether the methods used are calculated to answer the demands of scientific investigators in whose interest the catalogue was primarily undertaken. As is natural in any new enterprise and especially in one having to do with so many and diverse interests, criticism has been aroused; however on the whole the work has been well received and seems to bid fair to completely fill the expectations of its sponsors.

Sins of omissions are the principal ones charged, but as the organization is yet comparatively new this fault is expected to be only a temporary one and capable of being remedied, since the omissions in one volume can be made good in the next on the same subject. It should be understood that these annual issues are not year books, although after the volumes dealing with the literature of the present year (1905) it is expected that the work will be so well in hand and up to date that each subsequent yearly issue will practically index the literature of the previous year.

Leaving aside this question of promptness of treatment, which is only one of available funds and business organization, I come to that of the system of classification.

I believe that, upon reflection, it will be generally admitted that any system to be of permanent value must be elastic not only as regards its details but also in its main heads, which are of course based on the accepted theories of science for the time being.

[1] Read at the general meeting of the American Philosophical Society, Philadelphia, April 12, 1905.

As an illustration; how would an exact and inflexible system of classification of zoology or biology founded before the time of Darwin have treated the literature of his time and after. How would the exact chemical classification of Lavoisier's day deal with Mendeléeff's theory. As the present investigations in radiant energy seem to be setting the teachings of yesterday topsy turvy, so must we constantly expect, as new discoveries are made, radical changes in accepted theories in all branches of science, and as the literature of these subjects must be properly and thoroughly indexed as it appears, it is beyond question that any system of classification to be of any permanent value must be elastic, easily elastic, in root and branch.

The schedules of classification adopted at the beginning of the work and used up to the present time were the result of a systematic investigation made through the representative scientific institutions and societies throughout the world, and the needs of each science were thoroughly considered and made to harmonize, as far as then seemed possible, with the usage of all countries. But it is here that the main difficulty of the work is found both from the scientific and geographical point of view. This, however, was foreseen and provided for when the work was undertaken, as it was decided to hold an international convention in London during the present year to reconsider and revise, if necessary, the regulations under which the work is being carried on. The convention will be held in July and representatives from all countries will be invited there to discuss the result of their experience, with the object of correcting any faults which may exist. Zoological taxonomy seems to be more criticized from the point of view of the generally accepted methods used in the United States than any other branch of the work. However in all of the seventeen branches suggestions from the point of view of the expert user of the catalogue will be of the utmost value in eliminating defect.

I think no more fitting place and opportunity could be found than the present to earnestly solicit the aid of those interested in the welfare of science. Sets of the International Catalogue are in the library of this society and in most of the larger libraries throughout the country and are therefore easy of access. Concise and definite criticisms and suggestions from specialists in any of the sciences coming within the scope of the work will, if sent to the Smithsonian Institution, be brought to the attention of the international convention and as a result the needs of American scientific workers will be furthered and at the same time the undertaking as

a whole improved. Let me emphasize the fact that in order to be useful the criticisms and suggestions must be definite.

That the work is one of magnitude may be gathered from the fact that while now only in its third year of publication over half a million reference cards have been received at the London Central Bureau of which over fifty thousand are references sent for the United States from the Smithsonian Institution. The limited funds at our disposal delay and embarrass the work in this country; however the system as at present organized is capable of expansion at any time either into fields not at present embraced within the scope of the work, such as the so called applied sciences, or in adding to the manner of presenting the index. For instance, cards or proof sheets might be furnished immediately after the appearance of the publications indexed. Such methods would of course only be adjuncts to the yearly volumes which would always be the permanent records.

Recently a plan has been organized whereby authors of papers are in special cases communicated with in order that through the cooperation of author and indexer the subject matter may be completely treated from the point of view of the author and systematically treated from the point of view of the bibliographer.

This method entails considerable clerical work but the results seem to justify the effort. Another plan which is being gradually worked out as time permits is to send to each author from time to time a list of his papers which have been indexed at the institution for the catalogue with the request that attention be called to any omissions or errors which may exist. These two plans, were it possible to devote a sufficient time to them, would render the work as exact as it is possible to make a complex index.

The entire work of preparing cards for the United States is done at the Smithsonian Institution by five persons though we have the advantage of the advice of members of the staff of the Smithsonian Institution and the National Museum and in some cases also of persons connected with other government scientific bureaus.

I wish to specially acknowledge the services of Mr. Leonard C. Gunnell who is in immediate charge of the force to which I have referred.

The cost of the work in the United States thus far has been borne out of an allotment made by the Secretary of the Smithsonian Institution and the actual work is carried on in connection with the library of the institution.

INSTANCES OF HERMAPHRODITISM IN CRAYFISHES

By WILLIAM PERRY HAY

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Hermaphroditism, that condition in which both sexes are combined in the same individual, is an interesting deviation from the normal line of animal development and as it affects not only the organs of reproduction but extends its effects to all the secondary sexual characters as well, it is worthy of the biologist's attention. Among certain of the lower animals the hermaphroditic condition seems to be the normal one just as in the great number of flowering plants the normal condition is to have both pistil and stamens developed in the same flower, but in the case of these animals as in the flowers mentioned there is usually some device by which self fertilization is prevented or made very difficult. Among those animals and plants in which distinct sexes have been developed hermaphroditism is very rare. In animals there is a period during which the embryo is non-sexual but its subsequent development is almost invariably along either the male or the female line.

In the case of the decapod Crustacea the only instance of undoubted hermaphroditism recorded is that of the lobster, *Homarus vulgaris,* described and figured by F. Nicholls in 1730.[1] The specimen externally showed the male sexual organs on the left side and the female organs on the right side. On being dissected the internal sexual organs were found to correspond; the right half of the body, therefore, was normally female while the left half was normally male.

Coming now to the crayfishes, the first recorded instances of abnormal development of sexual characters are by Rosseau and Desmarest.[2] In these cases females of *Astacus fluviatilis* were observed to possess two pairs of sexual orifices, one on the third, the other on the fourth pair of legs, which led by a branched oviduct to the ovary on each side of the body.

In 1870 Von Martens described three specimens of an Australian

[1] *Philosophical Transactions of the Royal Society of London,* vol. XXXVI, No. 413, p. 290.

[2] *Annales de la Societe Entomologique de France,* 2d Series, VI, pp. 479 and 481, pl. XIII, 1848.

crayfish, *Cheraps preissii*,[1] in which the normal openings of the oviducts on the third pair of legs co-existed with male orifices on the fifth pair of legs. The specimens had been preserved in alcohol for several years and their internal organs were doubtless badly preserved. No ovary was detected and no oviduct leading to the openings on the third pair of legs. A similar arrangement of openings was noticed in males of *Parastacus brasiliensis* and *P. pilimanus*.

In 1892 von Ihring[2] reported that in *Parastacus brasiliensis* he had found that two sets of apertures, one on the third and the other on the fifth pair of legs, coexisted in every individual of the "several dozen" examined by him and that on dissection they all proved to be males.

In 1898 Faxon[3] stated that not only *Parastacus brasiliensis* and *P. pilimanus*, but *P. saffordi*, *P. varicosus*, *P. defossus* and *P. hassleri*, as well, seemed invariably to possess two sets of genital orifices. No dissection of any of the specimens was described.

In 1898 Lönnberg[4] had an opportunity to examine a series of *Parastacus hassleri* and his observations form a most valuable contribution to the present discussion. He found that while the two pairs of genital orifices were present in every individual it was still possible by comparative measurements to separate his specimens into two lots, one of which from the broader abdomen, shorter antennae and weaker chelipeds he regarded as females, while the other, with an opposite set of characters, he took to be males. An examination of the internal anatomy proved the correctness of his theory. The males possessed only testes, the females only ovaries. The arrangement of sperm ducts and oviducts, however, was very remarkable. From each generative gland there were two ducts passing downward, one to the fifth and the other to the third pair of legs. In the females the anterior of these ducts alone was complete and functional, the posterior one ended blindly and could be of no use. In the males the reverse was the case, the anterior duct ended blindly while the posterior one was functional as a sperm duct. A more critical examination of the external genital apertures was now made and it was found that in each case there was actually only one pair of openings, those on the third pair of legs in the males and on the fifth pair of legs in the females being only shams.

[1] *Sitzungsberichte der Gesellschaft Naturforschender Freunde zu Berlin*, 18th Januar, p. 3, 1870.

[2] Congress International de Zoologie à Moscou, Aug., 1892.

[3] *Proceedings of the U. S. National Museum*, xx, p. 683, 1898.

[4] *Zoologischer Anzeiger*, xxi, pp. 334–335 and 345–352, 1898.

The ovaries were so filled with ova that there seemed to be no room for anything else but in the testes there were found, on microscopical examination, along with the usual elements of that organ, certain spherical bodies which Lönnberg thought might be young eggs. The summary of his investigation, therefore, was as follows:

"1. The supernumerary genital orifices on the third pair of legs of the male *Parastacus hassleri* and those on the fifth pair of legs of the female are closed.

"2. Both sexes can be distinguished on an examination of the outer parts.

"3. In both sexes a pair of supernumerary genital ducts (thus four in all) are present corresponding to those of the opposite sex.

"4. It seems at least possible that the male generative gland contains female elements (eggs) although I do not think it probable that these can be fully developed, still less be of propagative use.

"Thus it may be said that in *Parastacus hassleri* a partial hermaphroditism is prevailing, but male and female organs are not functionary in the same individual, neither are ripe elements of both sexes produced by the same specimen."

Lönnberg further states that his investigations of abnormal specimens of *Astacus astacus,* with first abdominal appendages resembling those of the male but with genital aperatures on the third pair of legs, show these to be invariably females with no trace of hermaphroditism in the internal organs, a conclusion which agrees with that of Bergendal.[1]

In the light of Lönnberg's conclusion that the condition of partial hermaphroditism in *P. hassleri* probably exemplifies the condition to be found in other species of the genus, an examination has been made of the specimens of *P. hassleri, P. defossus, P. saffordi* and *P. varicosus* in the collection of the U. S. National Museum. In the first three species there is found only one pair of actual openings, as Lönnberg has described above, but in *P. varicosus* there seem to be two pairs. It may be that in the latter case one pair only is natural and the other has been made by a needle in the hands of some investigator, but if so I am quite unable to distinguish which is the natural and which the artificial opening. It is very easy indeed to break through the shell at either of the points mentioned in any of the species, more easy perhaps in *P. defossus* and *P. saffordi* than in *P. hassleri,* as the apex of the tubercle on the fifth pair of legs is membranous only and the depressed operculum-like area on the third pair of legs is thin.

[1] *Bihang K. Sv. Vet. Akad. Handl.,* XIV, 1888, and XV, 1889.

From the evidence now before me I would say that undoubtedly a partial hermaphroditism as indicated by the two sets of ducts described by Lönnberg or a more complete hermaphroditism as shown by the two sets of genital orifices in *P. varicosus* is the normal condition in the species *P. brasiliensis, P. pilimanus, P. hassleri, P. defossus, P. saffordi* and *P. varicosus,* while contrasted to this group is *P. agassizi* which, so far as the dissection of one specimen will prove, does not possess more than a single pair of genital orifices or tubes.

In the genus *Cambarus* four specimens, two of *C. propinquus sanborni,* one of *C. diogenes* and one of *C. propinquus* have been described by Faxon[1] as showing to a greater or less degree a combination of sexual characters.

In the first specimen, *C. propinquus sanborni,* 60 mm. long, all the characters were those of the female, but the external openings of the generative organs were situated as in the male sex, upon a small papilla on the basal joint of each of the fifth pair of legs. The second specimen, belonging to the same species, 38 mm. long, was likewise a female in every way except that the first pair of abdominal appendages were like those of the male. The third specimen, *C. diogenes,* 84 mm. long, had all the external characters of the female except the first abdominal appendages which were curiously modified so as to resemble the same parts in the males of the genus *Astacus;* they were smaller in size and lacked the two large, recurved hooks of the normal *C. diogenes.* The fourth specimen, *C. propinquus,* 72 mm. long, agreed with the female in every respect except that the first pair of abdominal appendages were partly transformed into the condition which obtains in the male. The transformation was greater on the left side although on neither had it gone far enough to produce a perfect male appendage. A dissection of the first described specimen revealed the presence of many large ovarian eggs and Dr. Faxon's opinion was that the other three in all probability were females which had assumed some of the characters of the opposite sex.

To the list commented on above it is now possible to add four more. In the course of the examination of the extensive series of crayfish collected by the U. S. Fish Commission and by myself, all of which have been deposited in the U. S. National Museum, I have found two specimens of *C. spinosus,* one of *C. propinquus* and one of *C. affinis* which show evidences of hemaphroditism.

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[1] *Memoirs of the Museum of Comparative Zoology,* x, No. 4, p. 13, 1885.

The first two, *C. spinosus,* were collected from Clinch R., Tennessee, by Dr. B. W. Evermann, Oct. 12, 1893, and bear the U. S. National Museum number of 20,835. They are both 91 mm. in length and may be distinguished as number 1 and number 2.

In number 1 the general appearance is that of a young or second form male. The third pair of legs is hooked and the second pair of abdominal appendages is exactly as in the normal male. The first abdominal appendage of the right side is like that of the normal *C. spinosus* of the second form but is possibly a little short. The corresponding appendage of the left side is shorter, the outer ramus is fairly well formed but the inner is much stunted and bent strongly downward. The basal segment of the fifth pair of legs is imperforate although it bears a small papilla. There is a well developed annulus ventralis of the same structure but a little less prominent than in the normal female and the openings of the oviducts are perfectly formed and operculate and situated, as is usual, on the basal segments of the third pair of legs.

A dissection of this specimen fails to show any trace of male organs internally but there is a well developed ovary filled with nearly mature eggs.

In number 2 the general appearance is more like that of the female, the abdomen being broader and the chelipeds shorter than in number 1. Otherwise it corresponds perfectly with number 1 except that the first pair of abdominal appendages are short and blunt and are not provided with the long, slender tips characteristic of the males of this species. A dissection of this specimen shows it to correspond exactly with number 1.

The third specimen, *C. propinquus,* 53 mm. long, from near Sandusky, Ohio, is in general appearance a male of the second form but an examination of the ventral surface shows a striking lack of symmetry, the right side being more strongly feminine, while the left side is masculine. Thus on the right side, on the third pair of legs, there is a normally formed and operculate opening of an oviduct; this is not even indicated on the opposite side. On the other hand, the left leg of the third pair bears the usual small hook characteristic of the male, while the right leg shows no trace of it. The annulus ventralis, rather lower than usual, has the outline and sculpture characteristic of the species but the small conical elevation just behind it, on the sternum of the last thoracic segment, bears a pencil of hairs exactly as in the male. The first abdominal appendage of the left side is entirely similar to the usual second form appendage of the species and the basal segment of the contiguous fifth leg is

perforated by the opening of the sperm duct. The first abdominal appendage of the right side, while of the same pattern, is misshapen and only half as long as its fellow and the basal segment of the contiguous fifth leg is imperforate. The second abdominal appendage of the left side is developed as in the male while on the right side it is as in the female.

A careful dissection of this specimen has been attempted but it has been so poorly preserved that nothing can be determined. There is a large mass which is probably the ovary, but there is no trace of a spermary or sperm ducts and even the oviduct can not be identified with certainty.

The fourth specimen, *C. affinis,* 106 mm. long, from the Potomac River, near Washington, has all the external characters of a fully developed first form male except that on the basal segment of the third pair of legs there is, on each side, an orifice of an oviduct. These orifices are not operculate and in the living animal the white oviducts protruded conspicuously and first called my attention to the specimen. A careful examination shows no other female characters except that the basal segment of the fifth leg of the left side is not perforated by a sperm duct. The first pair of abdominal appendages are perfectly formed and the third pair of legs bear strong hooks. The internal organs of this specimen show a most astonishing reversal of conditions. There is a large ovary, a little more developed on the left side than on the right, well filled with nearly mature eggs. On each side a perfectly formed oviduct passes downward to the bases of the third legs. On the right side a short and not much coiled sperm duct leads upward from the base of the fifth leg to a rudimentary spermary which lies directly upon the ovarian mass and is partially imbedded in it. The diameter of the spermary is about four millimeters and its greatest thickness about two and a half millimeters. There is not the slightest trace of a spermary or sperm duct on the left side.

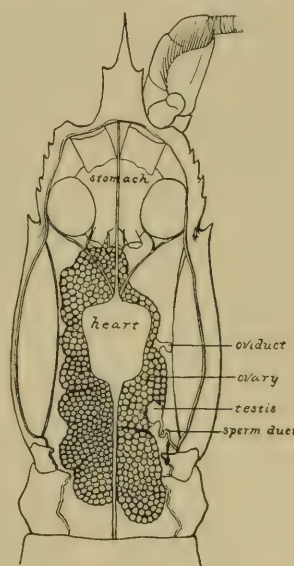

FIG. 27.—Dorsal view of an hermaphroditic individual of *Cambarus affinis.*

A microscopic examination of the spermary and the sperm duct have failed to show the presence of spermatozoa but there is a

thick epithelial layer which seems to be exactly like the spermatophoral cell layer of normal males. I therefore have little doubt that this specimen was capable of producing some spermatozoa. From the appearance of the ovaries it seems very probable that had the specimen been allowed to live, it would have produced a large number of perfectly normal eggs.

It might be added that during the time the specimen was kept alive it was seen in conjugation with a female of the same species and a little later was itself seized and held for a short time in the usual manner by a male. The latter, however, is a matter of little importance as I have several times observed the same thing in the case of two males neither of which was hermaphroditic.

It will be observed that of all the specimens belonging to the genus *Cambarus* described both by Dr. Faxon and myself only a single one, the individual of *C. affinis*, had perfectly developed external male characters. In all the other cases, with the possible exception of specimen number 1 of *C. spinosus*, the female characters were so strongly developed as to be unmistakable indices to the sex. Such dissection as was possible under the circumstances bore out perfectly the external indications and we may say without hesitation that the individuals were females. Even in the case of the specimen of *C. affinis* the internal organs pointed unmistakably to the conclusion that it too was functionally more a female than a male. It would therefore appear that in the genus *Cambarus* at least, hermaphroditic individuals are females which, owing to some ambiguity of the formative cells in the embryo, have developed to a greater or less degree the characters of the opposite sex. The condition is a very rare one and is usually shown in the external organs only. It has been observed by students of teratology that hermaphroditic individuals, in certain species, at least, as they grow older show masculine characters more and more strongly and it may be that something of the kind occurs in crayfishes. Most of the specimens of these animals which have been examined were small, the only fully adult one (*C. affinis*) had the most perfectly developed hermaphroditic characters and the inference is possible that this perfection of the male organs had been acquired with age.

In the genus *Astacus* indications of hemaphroditism appear to be quite as uncommon as in *Cambarus*. Among the Parastacidæ the condition of apparent hermaphroditism seems to be established in the genus *Parastacus* and may also be found to obtain in *Cheraps* but evidently is rare or altogether wanting in the other genera.

NOTES

Inventory of Rigaud Papers in Bodleian Library, Oxford, England

The accompanying list of the papers of Prof. Stephen Peter Rigaud, which, after his death in 1839, were deposited in the Bodleian Library, Oxford, England, was kindly sent to the writer by Mr. Ralph J. Beevor, M.A. (Trin. Coll., Cambridge), 22 Craven Street, Strand, London, W. C., with a letter dated at the Limes, Weybridge, Surrey, Easter Monday, April 13, 1903. This is a valuable collection of inedited material, the existence and general nature of which should be widely known. The list below is copied exactly from Mr. Beevor's memorandum, the notes being also his, made after "a (necessarily) cursory examination" while at Oxford for a day's visit.

1. Bayer, C. J. Unanometria. 1654.
2. 5 papers relating to Hadley and the quadrant invented by him.
3. Sandersoni Physica.
4. Professor Saunderson's lectures upon hydrostatics.
5. Pound.
6. Bradley.

7, 8. Hailey [*i. e.* Halley; see note below].

9. Scient. biogr.

10, 11. Hearne.

12. Indexes.

13. 2 alphabetical catalogues of books.

14, 15. Horrox. Transcripts of MSS. at Greenwich.

16–22. Mathematical Tracts. 7 vols.

23–33. Commonplace books, 1807–1837; 11 vols. (with loose index to vols. 9–11).

34. A memorandum of Dr. Bradley's lectures.

35. Hadley, Harriot and Lower.

36. Miscellaneous.

37. Halley & Stirling.

38. Letters of scientific men, 18th cent.

39. Copy of Act of Parliament on Marquis of Worcester's water commanding engine.

40–59. Loose papers between boards mostly octavo size; lettered A–U.

40. A. Miscellaneous.

41. B. Miscellaneous.

42. C. Delambre, Lelande & Vinch.

43. D. Miscellaneous.
44. E.
45. F.
46. G.
47. H.
48. I.
49. K.
50. L.
51. M. Inchoata.
52. N. Portraits of remarkable men.
53. O. Copybooks, miscellaneous.
54. P. Copybooks and other papers.
55. Q. Lectures on astronomy.
56. R. Miscellaneous.
57. S. Early mathematical studies of Prof. Rigaud.
58. T. Bundle of pamphlets. Jordan on light, mathematical questions, etc.
59. U. 6 printed papers.
60. Rigaud letters. Vol. I. A–E.
61. Rigaud letters. Vol. II. F–M.
62. Rigaud letters. Vol. III. N–W.
63. Catalogue of pamphlets.
64–65. Catalogue of the Savile Library, 2 vols.
66. Rigaud, S. J. Defence of Halley.
67. Catalogue of the Savile Library.
68. Rigaud (Major Gen. Gibbes) Catalogue of MSS. Rigaud 1–62.

[Extracts from notes by Mr. Beevor.]

"I looked at 7, 8, 37, 60, 66, 68."

"Hailey (*sic*) 8: p. 27. To Dr. Halley at his house the corner of Bridgewater Square in Barbican, July 16, 1716. 'Hailey' here is merely a transcriber's error. The word 'Halley' is lettered at the back of each volume and being rather worn could easily be misread 'Hailey.'"

"37. Halley & Stirling. This MS., as far as I could learn from a cursory examination contained no biographical data of importance about Edm. Halley."

"MS. Rigaud, 68, gives an abstract of the contents of the S. P. Rigaud papers. I examined this with a view of finding whether the miscellaneous papers contained any reference to the Halley biography." [See MS. life of Halley, in Observatory library, Oxford.]

"68 gives an index to the letters contained in 60, 61, 62. None of the names of writers of these letters was suggestive. I read through those from Sir David Brewster but learned nothing from them. Of course it is possible that a more minute and complete search might have been more fruitful, but I presume to believe that

if the papers contained any biographical details of importance they would not have escaped me."

[Mr. Beevor here refers to the life of Dr. Edmond Halley, as yet unwritten. With the mine of inedited material on that subject, now available, and the exceedingly fortuitous circumstance of the predicted return of Halley's comet, in 1910, it will, indeed, be surprising if no English scholar undertakes the preparation of an adequate biography of "the second most illustrious of Anglo-Saxon philosophers." The subject is one which, owing to Halley's varied career, would readily lend itself to popular treatment, without detracting from the scientific value of the resultant work.

—Eugene Fairfield McPike.]

Monument to Prof. Ernst Abbe

A movement is in progress in Jena for the erection of a monument to Ernst Abbe, who was for many years connected with the university in that city. While distinguished for eminence in mathematics, Professor Abbe devoted much attention to its application to the natural sciences, and is widely known for his work in connection with the design and perfection of optical instruments, especially those relating to microscopy and photography.

His fellow citizens remember him also as a pioneer in social science who, with characteristic unselfishness, set aside the thought of his own advantage in the endeavor to assure the full fruit of his work to those who should come after him. The present spontaneous movement towards the erection of an artistic monument in Jena to his memory is an indication of the affectionate remembrance cherished for Professor Abbe in his former home.

Smithsonian Delegates to International Congresses

Dr. Leonhard Stejneger, curator of the division of reptiles and batrachians in the National Museum, represented the Smithsonian Institution and the Museum at the Fourth International Ornithological Congress at London, June 12 to 17, 1905, and will also represent the Smithsonian Institution at the International Convention of the International Catalogue of Scientific Literature to be held in London beginning July 25.

Mr. F. V. Coville, curator of the division of plants in the National Museum represented the Smithsonian Institution and the Museum at the Second International Botanical Congress at Vienna, June 11 to 18, 1905.

Dr. WILLIAM JAMES, professor of philosophy at Harvard University was designated to represent the Smithsonian Institution at the Fifth International Congress of Psychology at Rome, April 26 to 30.

Announcement has been made of the First International Congress for the Study of Radiology and Ionization to be held at Liege, September 12 to 14, under the patronage of the Belgian Government. The programme is divided into a Physico-Chemical Section and a Biological Section.

ARCHÆOLOGY OF GULF STATES OF MEXICO

Dr. J. Walter Fewkes, a member of the Bureau of American Ethnology, has lately returned to Washington from an extended archæological reconnoissance for the Smithsonian Institution in the Gulf states of Mexico. His trip has been successful, adding information to what is known of the prehistoric inhabitants of this rich but only partially explored region. While the main object of this visit was the increase of our knowledge of Mexican archæology attention was incidentally given to the striking likeness of many prehistoric objects observed to those from the United States and its bearing on the question of culture migrations. An area was chosen in each of the states of Vera Cruz and Tamaulipas, as typical of the prehistoric culture of this region, one of these extending from Xalapa, capital of Vera Cruz, to the gulf coast, the other being near the city of Tampico on the banks of the Panuco and Tamese rivers.

The numerous ruins or mounds that occur in these areas, rarely visited by archæologists, are supposed to be typical of the former culture of two great allied peoples, the Totonacs and Huaxtecs, who in prehistoric times inhabited the greater part of Vera Cruz and what is now southern Tamaulipas.

On account of its historical as well as archæological importance, a visit was made to the little-known ruin of Cempoalan, a Totonac metropolis visited by Cortes, the conqueror of Mexico. Archæological literature pertaining to this city is very scanty; there is not a single description in English of the still well-preserved temples of this remarkable capital. On his visit to the site of Cempoalan Dr. Fewkes obtained many fine photographs of the four stately pyramids and gathered much data regarding their construction. He also studied and took photographs of the many small objects found in the neighborhood of the mounds that will later be published. An attempt to determine the site of another flourishing

Totonac city revealed, near the ancient Villa Rica de la Vera Cruz, an important cluster of earth mounds of considerable size. These were also photographed and their relics studied.

Dr. Fewkes visited several large ruins in the neighborhood of Xalapa, one of which, near Xicochimalco, he has identified as the remains of the pueblo of Sochimatl, mentioned by Bernal Diaz del Castillo, historian of the Conquest. By this identification new light is shed on the hitherto obscurely known route of the conquerors from Cempoalan over the mountains to the Plateau of Mexico.

The extensive group of large earth mounds, some of which are remains of pyramidal temples, situated at Texolo, near Xico, were also visited, and important material was gathered from them, bearing on their prehistoric inhabitants. Some time was very profitably employed at Xalapa in studying and photographing the remarkable Dehesa collection, many objects in which are unique and undescribed. These are of high artistic merit and of priceless value for the study of Totonac culture. The numerous ruins in the vicinity of Tampico were found to be extensive, and objects from them revealed evidences of a high development of culture.

Of the large Huaxtec pueblo called Chila, subdued by Cortez, nothing now remains but a group of mounds in an almost impenetrable forest a few miles from Tamos. Many sites of prehistoric pueblos were found on the banks of the Panuco; some of these were once temples, others mortuary hillocks containing pottery offerings and bones of the dead. Numerous shell heaps occur in this region, some of which were visited and examined. About a mile from Tampico, Dr. Fewkes reports, he found a cluster of large earth mounds of considerable extent, up to within a few years concealed by a dense jungle.

The most notable ruins in this region lie on the banks of the Champayan lagoon at the Rancho de San Francisco and Cebadella. In the Sierra de Palma there is a pyramid having a cut stone facing and stairways similar to those in the Totonac region.

Photographs were obtained of typical ruins and mounds near Tampico, and studies were made of local collections from them of idols, pottery and other artifacts.

A report on the reconnoissance is in preparation and will be published later.

Smithsonian Expedition in Search of Alaskan Mammoth

There has recently been published in Miscellaneous Collections an account of the expedition to Alaska and adjacent territory made

during the summer of 1904, by Mr. A. G. Maddren, under the direction of the Smithsonian Institution, in search of mammoth and other fossil remains. Mr. Maddren refers to observations made in 1899, when he travelled the length of the Yukon River; in 1900 when various points on the coasts of Bering Sea, eastern Siberia, and of the Arctic ocean as far east as Cape Beaufort were visited; and in 1902–03 when a year was spent in residence on the Alaska peninsula. During these previous years ice in various forms was frequently noted, but not until the summer of 1904 was it made a special object of notice in relation to the Pleistocene deposits.

Mr. Maddren's object was to find, if possible, complete skeletons of the mammoth and other large extinct mammals reported as occurring in that region or at least a locality promising enough in its indications to warrant further investigation. This search was confined to the Pleistocene deposits of northern Alaska in which most of the Mammoth and other vertebrate remains occur. Hence the observations treat of these formations and the criteria by which they are to be distinguished from the more recent ice and alluvial deposits which have been variously noticed and discussed by travellers and writers.

The problems of geographic distribution of the animal and vegetable life of North America in Pleistocene time with the disturbance of faunas and floras caused by the widespread glaciation during that period and their subsequent readjustment over the glaciated area, all combine to form a complex arrangement, to solve which will require large collections of specimens from the Pleistocene deposits of the unglaciated area of Alaska and the adjacent Canadian territory. For at present our knowledge of this fauna and flora is very limited. As far as we know, only one species of elephant (*Elephas primigenius*), the Mammoth, inhabited Alaska and Siberia during pleistocene time.

The longest mammoth tusk so far reported from Alaska is one 12 feet 10 inches long, measured on the outside of the curve. Remains of the rhinoceros have not been reported with those of the mammoth in Alaska, as in Siberia, and it also appears that the remains of the mammoth in Alaska are not in as fresh a state of preservation as those found in Siberia, which points to the surmise that the mammoth became extinct in Alaska before the last of the species succumbed in Siberia. Associated with the mammoth were herds of large bison and horses. This species of horse may have

been the last native to North America, the rear guard of the last migration of these animals across the region of Bering Straits to Asia before the land connection disappeared. There was a species of musk-ox together with sheep and bear. Descendants of these last three forms have by adaptive changes survived in these northern regions down to the present time.

The relation that the fauna and flora north of the area occupied by glaciers bore to that in the region of the United States before, during, and after separation by the snow and ice fields; also the relation of forms in Alaska to those of Siberia, with the time and duration of the land connection across Bering Straits and their subsequent separation, form a complex problem, the solution of which will require the accumulation of much material.

He summarizes his conclusions as follows:

I. That while remnants of the large Pleistocene mammal herds may have survived down to the Recent period and in some cases their direct descendants, as the musk-ox, to the present, most of them became extinct in Alaska with the close of Pleistocene.

II. The most rational way of explaining this extinction of animal life is by a gradual changing of the climate from more temperate conditions permitting of a forest vegetation much farther north than now, to the more severe climate of today which subduing the vegetation and thus reducing the food supply besides directly discomforting the animals themselves, has left only those forms capable of adapting themselves to the Recent conditions surviving in these regions to the present.

III. There are no facts to support the contention that the climate of the Arctic and sub-Arctic regions ever has been colder than it is at present. There are no phenomena presented in those regions that require a more severe climate than that now existing to account for them. There are no ice deposits in Alaska, except those of large glaciers that may be considered of Pleistocene age. There are no ice beds interstratified with the Pleistocene deposits of Alaska.

IV. That the various forms of land ice, together with the deposits of peat, now existing throughout the Arctic and sub-Arctic regions of Alaska belong to the Recent period and these deposits may be most conveniently and logically classified by their *position* with reference to the Pleistocene and Recent formations and the ice deposits cannot be differentiated satisfactorily into deposits of snow or of water origin by their physical structure and character alone.

THE HODGKINS FUND

In October, 1891, Thomas George Hodgkins, Esq., of Setauket, New York, made a donation to the Smithsonian Institution, the income from a part of which was to be devoted " to the increase and diffusion of more exact knowledge in regard to the nature and properties of atmospheric air in connection with the welfare of man."

These properties may be considered in their bearing upon any or all of the sciences,—*e. g.*, not only in regard to meteorology, but in connection with hygiene, or with physics, or with any department whatever, either of biological or physical knowledge.

With the intent of furthering the donor's known wishes, the Institution has already given a number of money prizes for treatises embodying new and important discoveries in regard to the nature or properties of air. This form of encouragement will not at present be renewed.

A gold medal has been established under the name of the " Hodgkins Medal of the Smithsonian Institution," which may be awarded annually or biennially for important contributions to our knowledge of the nature and properties of atmospheric air, or for practical applications of our existing knowledge of them to the welfare of mankind.

Grants of money are made from time to time to specialists engaged in original investigations which involve the study of the properties of atmospheric air, accepting the phrase in its widest sense.

Thus the physicist may consider these properties in an investigation which involves the study, for instance, of atmospheric electricity, or of the absorptive powers of the air, or of the atmospheric lines in the spectrum; the hygienist may be assisted in researches in this connection looking to the promotion of health; or even the geologist, in a study which connects the earth's crust with the absorption of the constituents of the atmosphere in past or coming time.

The Hodgkins Fund may thus be considered to cover in effect some subject belonging to nearly every division of the applied sciences.

It being the desire of the Institution to give the widest extension to the great purpose of the founder of this fund and to prevent any misapprehension of his wishes, it is repeated, that the discoveries or applications proper to be brought to the consideration of the Institution may be in the field of any department of science without restriction, provided only that they have to do with " the nature and properties of atmospheric air in connection with the welfare of man."

The following conditions are imposed with a view to obtaining the fullest possible benefit to science from grants made from the fund.

1. Applications for grants should have the endorsement of some recognized academy of sciences, or other institution of learning, and should be accompanied by evidence of the capacity of the applicant, in the form of at least one memoir already published by him, based upon original investigation.

2. The purchase of necessary laboratory appliances for the particular research in view is authorized and, on explanation by the applicant, the payment of the salaries of assistants in prosecuting such research; but the defrayment of the purely personal expenses of the grantee is not intended to be provided from moneys advanced from the Fund.

3. Upon the conclusion of a research, it is expected that any special apparatus purchased with means granted from the Fund will be returned to the Smithsonian Institution.

4. Should investigations for which a grant has been made be of considerable duration, a summary of progress should be submitted to the Institution at the end of six months, as well as a subsequent report in which the results of such investigations may be recorded.

5. The Institution does not claim any legal property in a research promoted by its aid, but it expects to make the first publication of the results obtained, if it desire to do so. If this cannot be done without delay, and if the results seem to require it, the Institution will, as hitherto, when requested, interpose no obstacle to the publication elsewhere of the fullest abstract of such results, with the understanding that acknowledgment shall be made therein of the assistance given by it in promoting the research for which the advances have been made.

All communications in regard to the Hodgkins Fund, medals and publications, and all applications for grants of money, should be addressed to S. P. Langley, Secretary of the Smithsonian Institution, Washington, U. S. A.

Smithsonian Table at Naples Zoological Station [1]

In response to a memorial signed by nearly two hundred biologists, representing about eighty universities, colleges and scientific institutions in the United States, the Smithsonian Institution has for the past twelve years supported a table at the Naples Zoological

[1] For a detailed account see H. W. Burnside's paper in Smithsonian Quarterly, Vol. II, Part I, No. 1476.

Station. During that period free use of this table has been granted to about forty specialists in various lines of biological research.

Applications for the Smithsonian seat have been numerous, and although the collective appointments for any year have but twice exceeded an occupancy of twelve months for one student, not infrequently two, and in rare instances three occupants have been accommodated at the same time through the kindness of Doctor Dohrn, the Director.

In the interest of science and in order that the utmost possible benefit may be derived from the table supported by the Smithsonian Institution, it is desired that the aggregate time of appointments for each year shall equal the continuous occupancy of one student for the same period. With this object in view the conditions on which the seat is granted have been made such as can be reasonably complied with, so that while it is an advantage in the way of completing the permanent record of each occupant for an investigator to make as full a statement of his scientific history, publications, etc., as convenient, it is essential to submit with a request for a seat only such data as will show the capacity of the applicant for original work in embryological, histological, and other fields for which special facilities are offered at Naples.

The individual periods of occupancy of the Smithsonian table have varied in length from a month to six months, it having been decided in the interest of all who desire the seat that no appointment should be approved for longer than the latter term, although in exceptional cases an extension may be asked for and granted, if such action does not interfere with the occupancy of other applicants.

In order to give all prospective appointees equal opportunities to avail themselves of the advantage of the table, the Smithsonian seat is not assigned more than six months in advance of the date for which it is desired; it has therefore been requested that applications be submitted at the time when it is in order to take them up for consideration. Should more than one request be filed for the same period, appointment is made according to priority of application, within the specified six months.

An application for a seat accompanied with historical data and recommendatory letters is referred to an Advisory Committee for consideration and report, and on this report the Secretary of the Institution bases his action. In case of approval, the Director of the Station is notified and a summary of the appointee's scientific history is transmitted to him, so that each investigator finds himself introduced in advance to Doctor Dohrn and his assistants.

While a circumstantial report of the work accomplished at Naples has never been required, those whose applications are approved are requested to notify the Secretary at the close of a session, and at the same time to present a brief outline of their investigations. In this way the institution is able to keep in touch not only with the work of its special appointees, but also to obtain an interesting insight into the admirable methods employed at the Station for the accommodation of investigators. A summary of the data thus submitted has appeared at intervals in the Smithsonian publications, the action of the Institution in this connection being designed to interfere in no way with the plans of the author as to publication elsewhere.

Doctor J. B. JOHNSON of the West Virginia University occupied the Smithsonian table from September 1, 1904, through February, 1905, during which time he completed an article on "The Morphology of the Vertebrate Head from the Viewpoint of the Functional Divisions of the Nervous System," and a paper on "The Cranial Nerve Components of Petromyzon." He also made a study of Amphioxus and devoted some time to the comparative study of the brain of selachians. Additional papers containing further results of his work will be published later.

Doctor STEWART PATON, formerly of Johns Hopkins University, occupied the table for three weeks from April 1, 1905.

NOTE ON THE NAME HENDERSONIA

In SMITHSONIAN MISCELLANEOUS COLLECTIONS, quarterly issue, No. 1590, p. 187, July 1, 1905, I proposed the name *Hendersonia* for a remarkable new genus of *Urocoptidæ* from Mexico. I am now informed that in a publication by Wagner (Vienna, 1905) entitled 'Helicineen Studien,' which has not yet reached our library, the same name has been proposed for our well known *Helicina occulta* Say.

I would therefore modify the name proposed by me into *Hendersoniella* in order to avoid the conflict which renders the later use of the name impracticable.—WILLIAM HEALEY DALL, July 12, 1905.

RECENT PUBLICATIONS OF THE SMITHSONIAN INSTITUTION

CONTINUED FROM LIST OF JUNE, 1905, IN PUBLICATION NO. 1583

No.	*Title*	*Series*	*Price*
1584	MADDREN, A. G. Smithsonian Exploration in Alaska in 1904 in search of Mammoth and other fossil remains.	M.C. XLIX	.35
1585	Smithsonian Miscellaneous Collections, *Quarterly Issue*, vol. III, part 2 (containing 1586–1594)...	M.C. XLVIII	.50
1586	WHITE, ANDREW D. The Diplomatic Service of the United States, with some hints toward its reform. (*Quarterly Issue*)..................	M.C. XLVIII.	.15
1587	BEAN, BARTON A. The history of the Whale Shark (Rhinodon Typicus Smith) (*Quarterly Issue*)	M.C. XLVIII	.10
1588	OBERHOLSER, H. C. The Avian Genus Bleda Bonaparte and some of its Allies (*Quarterly Issue*).	M.C. XLVIII	.05
1589	OSGOOD, WILFRED H. Scaphoceros tyrelli, an extinct ruminant from the Klondike gravels (*Quarterly Issue*).........................	M.C. XLVIII	.10
1590	DALL, WILLIAM H. A new genus and several new species of landshells collected in Central Mexico by Dr. Edward Palmer (*Quarterly Issue*)	M.C. XLVIII	.10
1591	GILL, THEODORE. The Family of Cyprinids and the Carp as its type (*Quarterly Issue*).........	M.C. XLVIII	.05
1592	ADLER, CYRUS. The International Catalogue (*Quarterly Issue*)......................	M.C. XLVIII	.05
1593	HAY, W. P. Instances of Hermaphroditism in Crayfishes (*Quarterly Issue*)..................	M.C. XLVIII	.10
1594	Notes to Quarterly Issue, Volume III, part 2....	M.C. XLVIII	.05

(In press: Revised edition of Smithsonian Meteorological Tables, Barus on Nucleation, and Smithsonian Report for 1904.)

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SMITHSONIAN MISCELLANEOUS COLLECTIONS

VOL. III QUARTERLY ISSUE PART 3

THE SPECIES OF MOSQUITOES IN THE GENUS MEGARHINUS

BY HARRISON G. DYAR AND FREDERICK KNAB

Since the publication of our paper on the classification of the Culicidæ by larval characters[1] we have had access to the adult material brought together for Dr. L. O. Howard's forthcoming monograph of the family. The result has been not only a change in the interpretation of the forms of *Megarhinus* previously dealt with by American writers, but also the bringing to light of many discrepancies in the European literature of the group. To begin with we will correct the prevailing error regarding the structure of the female palpi of *Megarhinus*. Theobald describes two forms (*M. purpureus* Theob. and *M. trichopygus* Wied.) in which the female has four-jointed palpi, the last segment long, tapering and slightly curved like the fifth of the male palpi.[2] When there was no such terminal segment present he assumed the last segment to be broken off. Therefore in his diagnosis of the genus he says: "the female palpi are 4- or 5-jointed."[3]

A careful search through Mr. Theobald's descriptions does not reveal any female with a fifth segment on the palpi. Indeed, in two places, in the descriptions of the females of his *M. separatus* and *portoricensis* he describes the four-jointed palpus and adds "last joint missing."[4] The females of the seven species of *Megarhinus* before us have palpi of the type supposed by Theobald to be imperfect. Bred perfect specimens and close inspection show that there are only four segments present in the female. The terminal segment in these forms is rather stout, of about equal length with the

[1] The larvæ of Culicidæ classified as independent organisms. *Journ. N. Y. Entomological Soc.*, v. XIV, pp. 169–230 (1906).

[2] Monograph of the Culicidæ, v. 1, pp. 230–231 (1901); v. 3, pp. 115–116 (1903).

[3] *L. c.*, v. 1, p. 215.

[4] *L. c.*, v. 1, p. 221 and p. 233.

second segment or slightly shorter, cylindrical, straight-sided and truncate at the tip. The apex has a surrounding crest of scales and short spines which indeed gives it, superficially, the appearance of a broken joint, but close examination shows the tip, within the surrounding crest, to be densely clothed with metallic scales—a condition which would certainly not obtain on the insertion of another segment. This error was already committed by Macquart, who credits the female *Megarhinus hæmorrhoidalis* with five-jointed palpi and explains in a foot-note: "Un individu ♀ du muséum d'histoire naturelle a le 5.^e article des palpes brisé, de sorte qu'il n'est pas possible d'en déterminer la longueur."[1] In the figure of the female head on Pl. I he shows the four actual segments in heavy outline, and, dotted in, the supposed fifth segment. Dr. Lutz, in Bourroul's work, which we know only from the extracts in Blanchard,[2] seems to have recognized the true condition. He erects for the forms in which the female has the terminal segment of the palpi long, sabre shaped, the genus *Ankylorhynchus,* including *M. violaceus, M. trichopygus* (Wied.) and a new species, *A. neglectus.* In the two sexes the relative proportions of the corresponding palpal segments do not agree. These relative proportions appear to serve very well in the separation of the two forms (at least in the male) treated by Lynch-Arribálzaga[3] and subsequent authors as *M. separatus* and *M. hæmorrhoidalis* but offer no easy distinctions in the closely related forms here described.

It should be noted that all the old world Megarhini of which the structure of the female palpi has become known have been referred to *Toxorhynchites,* while all the American forms belong to *Megarhinus* and *Ankylorhynchus.* The only exception is the *Culex splendens* of Wiedemann from the East Indies, which Theobald has definitely referred to *Megarhinus*[4]; however nothing has appeared in print to throw light on the structure of the female palpi in this species. According to Theobald there are no characters to separate the males of these genera. We will not say that these genera should be merged, for good characters may yet be found to separate the males as well, but certainly they do not deserve sub-family rank. We have already expressed our views regarding the use of the length of the palpi for primary division in the Culicidæ.[5]

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[1] Diptères exotiques, v. I, p. 32 (1838).
[2] Les Moustiques, 1905.
[3] Revista del Museo de La Plata, v. I, pp. 376–377; v. 2, pp. 133–134 (1891).
[4] Genera Insectorum, 26 fascicule, p. 13 (1905).
[5] *Journ. N. Y. Ent. Soc.,* v. XIV, pp. 171–172.

The canvas of the literature involved in these studies has revealed a strange condition regarding the status of the oldest species and the type of the genus, the *Culex hæmorrhoidalis* of Fabricius. Arribálzaga discovered that there were two very similar species and described one of them as new. Unfortunately the form he described as new, under the name *Megarhina separata*, is the Fabrician *hæmorrhoidalis*—or at least it comes nearest to it of the two. Arribálzaga argued that the species Macquart described[1] could not be *hæmorrhoidalis* because the females had white-ringed tarsi while the females of his (assumed) *hæmorrhoidalis* showed no trace of such markings. His *separata* was described from the male alone and as he says nothing of the female it must have been unknown to him. Macquart's specimens unquestionably represent the true *hæmorrhoidalis* for they came from the type-locality, Cayenne, and the neighboring British Guiana, and in the description he definitely states that the third and fourth segments of the palpi are of equal length in the male. The hind tarsi of his females are white-ringed. Thus the *M. hæmorrhoidalis* of Arribálzaga and subsequent authors is the new species and is characterized by the long third segment of the palpi of the male and the absence of white on the tarsi of the female. In his table of *Megarhinus*[2] Theobald attributes white-ringed tarsi to the females of both species, but as no description of the female of his *hæmorrhoidalis* follows we take this to be merely an assumption. Giles's statement, under *M. hæmorrhoidalis*,[3] that the middle and hind tarsi of the female are white-ringed seems to be an error of compilation, for his remarks do not appear to have been based upon specimens. We propose for this form the name *lynchi*. The references and synonymy of the two species should stand as follows:

MEGARHINUS HÆMORRHOIDALIS (Fabricius)

Culex hæmorrhoidalis FABRICIUS, 1794, Entomologia Systematica, v. 4, p. 401, no. 5.

Culex hæmorrhoidalis, FABRICIUS, 1805, Systema Antliatorum, p. 35, no. 8.

Megarhinus hæmorrhoidalis, ROBINEAU-DESVOIDY, 1827, Mémoires de la Soc. d'hist. nat. de Paris, v. 3, p. 412.

Culex hæmorrhoidalis, WIEDEMANN, 1828, Aussereuropäische zweiflügelige Insekten, v. 1, p. 2.

Culex hæmorrhoidalis MACQUART, 1834, Histoire naturelle des Insectes, Diptères, v. 1, p. 33.

Megarhina hæmorrhoidalis MACQUART, 1838, Diptères exotiques, v. 1, p. 32.

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[1] Diptères exotiques, v. 1, p. 32 (1838).

[2] Mon. Culic., v. 1, p. 218.

[3] Gnats or Mosquitoes, 2 ed., p. 270 (1902).

Megarhina separata LYNCH-ARRIBÁLZAGA, 1891, Revista del Museo de La Plata, v. 2, pp. 133–134.

Megarhinus separatus THEOBALD, 1901, Monograph of the Culicidæ, v. 1, pp. 219–221.

Megarhina separata GILES, 1902, Handbook of the gnats or mosquitoes, 2 ed., p. 270.

Megarhinus hæmorrhoidalis (in part), *M. separatus* BLANCHARD, 1905, Les Moustiques, pp. 222–223.

Megarhinus separatus GOELDI, 1905, Os mosquitos no Pará, pp. 124–127, Pl. N & Pl. 5, fig. 19.

MEGARHINUS LYNCHI new name

Megarhina hæmorrhoidalis LYNCH-ARRIBALZAGA, 1891, Revista del Museo de La Plata, v. 1, pp. 376–377.

Megarhinus hæmorrhoidalis THEOBALD, 1901, Monograph of the Culicidæ, v. 1, pp. 222–223.

Megarhina hæmorrhoidalis (the male only) GILES, 1902, Handbook of the gnats or mosquitoes, 2 ed., p. 270.

Megarhinus hæmorrhoidalis BLANCHARD, 1905, Les Moustiques, p. 222.

A critical examination of our specimens of *Megarhinus* with white tarsal markings shows that Mr. Coquillett, in his characterization of *M. rutila* and *portoricensis*,[1] has included and confused a number of closely related species. Indeed, the entire literature on these forms is in a most unsatisfactory condition, as we shall point out in detail in the course of the following remarks. Doubtless the trouble has largely arisen through the use of scanty and damaged material, but also through a lack of discrimination in the identification of the early descriptions.

We now have before us no less than 60 specimens of *Megarhinus* with white tarsal markings, a larger number by far than has ever before been available together, and this study has brought to light the existence of a number of closely related species. Great confusion has been caused by basing the diagnosis on the tarsal markings without reference to sex. We find that when the sexual differences are taken into account the tarsal markings are a useful guide in the diagnosis of the species and are a much more constant character than has been supposed. The fact that among the material from the North American continent there were no females which would fit the diagnosis of *portoricensis* should have aroused suspicion, but the small number of female specimens available would account for this oversight. The material before us shows that no less than six distinct

[1] A classification of the mosquitoes of North and Middle America. By. D. W. Coquillett. Technical Series, No. 11, U. S. Dept. Agric., Bureau of Ent., p. 14 (1906).

forms have been included under the two specific names given above. Of these six species the only one that we can safely refer to any described species is *M. rutila* Coquillett, of which the type is before us. *M. portoricensis* was described by von Röder[1] from a single male and the description is not sufficiently detailed to warrant identification without material from the type-locality. The three specimens, from widely separated localities, which Theobald had before him in drawing up his description of *portoricensis*[2] most likely represent as many distinct species, while his supplementary remarks[3] doubtless apply to still another. Von Röder's single male had the fourth segment of the hind tarsi only white, Theobald gives in his diagnosis of the species: "Legs steel blue, golden beneath the femora, penultimate tarsal joint white," and apparently meant to include all the legs. In his concluding "observations" however, he says: "The penultimate tarsal joint of the hind legs only is white in this species." It remains to be seen if in the true *portoricensis* this is true for the female as well as the male. Of Mr. Theobald's three specimens one was Walker's *M. ferox* from Georgia.[4] This specimen, most likely a broken one, is certainly wrongly associated with *portoricensis* and in all probability is the *M. septentrionalis* described here. Certainly in the 50 specimens of *Megarhinus* from the North American continent now before us there is no specimen with only the hind tarsi marked with white. In all probability the two specimens from the island of St. Vincent, referred by Williston to *portoricensis*,[5] represent a distinct form. Of the material in our collection from three of the West Indian islands the specimens from each island represent a distinct species and it is safe to assume that specimens from other islands will likewise prove distinct.

Neither can the *Culex ferox* of Wiedemann[6] be placed with certainty. The description is from a male in which the hind tarsi were absent. The third segment of the middle tarsi is white. In a supplementary note Wiedemann describes a male in the collection of Mr. von Winthem in Hamburg, which most likely was distinct from the previously described one. The fore legs were missing; the second and third segments of the middle tarsi are white, and the fourth of the hind tarsi. Theobald translates this note and wrongly credits it to

[1] *Entomologische Zeitung., entom. Vereine Stettin.*, v. 46, p. 337 (1885).
[2] Monograph of the Culicidæ, v. 1, pp. 232–233 (1901).
[3] *L. c.*, v. 3, p. 119.
[4] List of Dipterous insects in the British Museum, part 1, p. 1 (1848).
[5] *Transactions Entom. Soc., London*, 1896, p. 271.
[6] Aussereuropäische Zweiflügelige Insekten, v. 1, pp. 1, 2 (1828).

Giles.[1] As Mr. Theobald does not use the same terminology for the tarsal segments it will be seen that the species Theobald describes as *ferox* is distinct from that of Wiedemann. In Theobald's *ferox* the female has the second and third tarsal segments white on the front and middle legs, the fourth and fifth in the hind legs. In the male the fore tarsi are black, the hind tarsi with the fourth and fifth segments white, the middle tarsi missing. Although both of Wiedemann's males and the one described by Theobald; each had the tarsi of one pair of legs gone, careful comparison shows that the tarsal markings were different in all of them. There is some doubt about the fore and middle tarsi of the female of Theobald's form, for in the first diagnosis of the species the middle tarsi are omitted while in the full description which follows the front tarsi remain unmentioned. Theobald's species is obviously distinct and we propose for it the name *theobaldi*. *Culex ferox* Wiedemann is preoccupied by the earlier unrecognized *Culex ferox* von Humboldt[2] and we propose for Wiedemann's two forms the names (no. 2) *ambiguus* and (no. 1) *wiedemanni*.

Williston's *Megarrhina grandiosa*,[3] based upon a female from Omilteme in the state of Guerrero in Mexico, appears to have all the tarsi marked with white but the white is much more extensive than in any other species. In the fore legs the tip of the first and all of the succeeding segments are white, the middle tarsi were apparently missing, and in the hind legs the tip of the third, the fourth and the fifth segments are white.

Megarhinus longipes, Theobald,[4] from Mexico, is based on a single female. In the tarsal markings it appears to come very near *M. rutila* Coq., but the description shows that it differs in many points. The tip of the abdomen is yellow, the ventral surface apparently all golden-scaled. The predominating colors appear to be olive green and yellow shades.

None of the species mentioned so far show a pronounced caudal tuft. In the male of *septentrionalis* there is a faint approach towards it. The lateral hairs are slightly longer and coarser on the sixth and particularly on the seventh segments than on the preceding ones.

The *M. purpureus* of Theobald,[5] afterwards referred by him to the *violaceus* of Wiedemann,[6] also has at least some of the tarsi of

[1] Monogr. Culic., v. 1, pp. 237–239 (1901).
[2] Voyage aux regions équin. du nouv. Continent, VII, p. 340 (1819).
[3] Biologia Centrali Americana, Diptera, v. 1, p. 224 (1900).
[4] Mon. Culic., v. 1, pp. 241–242 (1901).
[5] Mon. Culic., v. 1, pp. 230–231.
[6] *L. c.*, v. 3, p. 117.

the female marked with white. However the structure of the female palpi at once separates this form from those considered here, a structure which Dr. Lutz has considered of generic value. Wiedemann's *violaceus*[2] was based on a male specimen from Bahia and was without any trace of white on the tarsi, as he expressly states. Of course it is quite likely that the sexes differ in this respect but it should be noted that Theobald's scanty material, all females, came from widely separated localities (Amazon, São Paulo, Santos, Rio de Janeiro), which, with the discrepancy in his remarks about the tarsi, arouses suspicion. At all events the species is to be excluded from the West Indian faunal region as the record[3] is based on a misidentified specimen from Trinidad which appears here under a new name.

Below we tabulate the species of *Megarhinus,* giving the diagnosis for the males and females separately. Although but seven species are before us we have included, as far as possible, the described species. We omit the forms treated under *ferox* by Wiedemann and Theobald, of which our knowledge is too unsatisfactory. Two other species, *M. mariæ* Bourroul and *M. solstitialis* Lutz are described in Bourroul's Mosquitos do Brasil, which we have not seen.

TABLE OF SPECIES

Males

1. Abdomen without conspicuous tufts....................................4.
   Abdomen red-tufted ....2.
2. Abdomen red-tufted on 7th segment only ....*superbus* n. sp.
   Abdomen red-tufted on 6th and 7th segments.........................3.
3. Palpi: segments 3 and 4 equal.........................*hæmorrhoidalis* F.
   Palpi: 3d segment longer than 4th.............................*lynchi* n. n.
4. Some or all the tarsi white-marked....................................5.
   Tarsi without white..................................*guadeloupensis* n. sp.
5. All the tarsi white-marked......................................*rutila* Coq.
   Middle and hind tarsi white-marked.....................................6.
   Hind tarsi only white-marked......*haitiensis* n. sp.; *portoricensis* v. Röd.
6. 4th segment only of hind tarsi white....................................7.
   4th and 5th segments of hind tarsi white...............*trinidadensis* n. sp.
7. Thorax with well-defined yellowish median and lateral stripes, *septentrionalis* n. sp.
   Thoracic stripes blue ....*moctezuma* n. sp.

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[1] Bourroul, Mosquitos do Brasil (1904).

[2] Aussereurop. zweiflüg. Insekten, v. 1, p. 3 (1828).

[3] Coquillett, Techn. Ser., No. 11, U. S. Dept. Agric., Bur. Ent., p. 14 (1906); Dyar and Knab, Journ. N. Y. Ent. Soc., XIV, p. 179 (1906).

Females

1. Abdomen without conspicuous lateral tufts............................3.
   Abdomen red-tufted ....2.
2. Hind tarsi ringed with white ....*hæmorrhoidalis* Fab.
   Tarsi without white ....*lynchi* n. n.
3. At least the hind tarsi white-marked..4.
   Hind tarsi without white, abdomen mostly purple and coppery-bronze, *superbus* n. sp.
4. All the tarsi white-marked...5.
   Middle and hind tarsi white-marked...............*guadeloupensis* n. sp.
   Hind tarsi only white-marked ....*haitiensis* n. sp.
5. Segments 2 and 3 of front and middle tarsi white.........................7.
   Segments 2, 3 and 4 of front and middle tarsi white.......................6.
   Segments 2, 3, 4 and 5 of front and middle tarsi white..*grandiosus* Will.
6. Abdomen beneath entirely golden........................*longipes* Theob.
   Abdomen beneath with blue median area......................*rutila* Coq.
7. Thorax marked with contrasting colors.....................................8.
   Thorax green-scaled on the disc.....................*trinidadensis* n. sp.
8. Thorax with well-defined yellowish median and lateral stripes, *septentrionalis* n. sp.
   Thoracic stripes blue ....*moctezuma* n. sp.

In the following descriptions the legs are assumed to be in their natural positions, the front legs directed forward, the others posteriorly. The measurements are for the body exclusive of head-appendages. The locality records given are all from the specimens on which the descriptions are based.

MEGARHINUS RUTILA Coquillett

The original description was obviously drawn up from material in part belonging to the form characterized here as *M. septentrionalis.* The seven specimens of *rutila* in the collection are more or less faded, and, all but the type (a male), badly damaged. The thoracic pattern is as in *septentrionalis;* the ground color is brown with coppery lustre, the light median and lateral stripes show a trace of pale blue but it is hardly possible to say what the original colors may have been.

Male.—The abdomen is deep blue above without the change to purple towards the tip noticeable in the following species. The seventh segment has the hind angles touched with gold and the eighth shows a couple of bright mauve spots. Beneath the median area is dark blue, the lateral stripes golden—these last are broadened on the seventh segment, leaving only a narrow stripe of blue, while the eighth segment is all blue. Lateral hairs pale yellow on all but the eighth and ninth segments, where they are dark.

Legs dark, the hind femora only with a trace of gold beneath; front tibiæ with a trace of golden on the outside. Front and middle tarsi with the second and part of the third segments white; in the hind tarsi the fourth and all but the tip of the fifth segments white.

Female.—The palpi are greenish blue and in proportion hardly differ from those of the same sex in *septentrionalis.* The second antennal segment is cylindrical and of the same diameter as the succeeding ones, less than twice as long as the third; the setæ arise from its middle, instead of near the base as in the succeeding segments, and the basal half bears upon its crest a dense cluster of erect, dark scales. Abdomen more or less green above. Lateral hairs pale yellow on all the segments, quite dense and coarse on the seventh segment where they form a kind of terminal brush. The lateral golden stripes are much broader than in the male and encroach upon the blue median ventral area.

Front tibiæ golden on the outside, the middle tibiæ on the inside. On the front and middle tarsi the tip of the first segment, all of the second and third, and nearly all of the fourth are white; on the hind tarsi the tip of the third segment, all of the fourth and all but the tip of the fifth are white.

Length, 8 mm.

Type No. 903, U. S. N. M.

Localities: Florida; Georgiana in Florida (Wm. Wittfeld).

3 ♂, 4 ♀. The record of Theobald and subsequent authors of "Georgia" is based on that of the above-mentioned town in Florida. This is the only species in which the male is known to have all the tarsi marked with white, but it will be noticed that even here there is a reduction in the white markings of the male.

MEGARHINUS SEPTENTRIONALIS new species

Male.—Head behind the eyes metallic blue, at the sides and beneath yellowish silvery. Antennæ densely plumose; second segment stout, laterally compressed, nearly as long as the next three and clothed on the upper part with golden and purple scales. Palpi dark violet; the second, third and fourth segments with many golden and iridescent scales, their apices pale violet; terminal segment nearly black. Second and fourth segments of about equal length, the third longer, the fifth about twice as long as the fourth. Prothoracic lobes light metallic blue. Mesothorax deep purple on the disc, the sides and a median stripe yellow, clearly defined. A patch of blue scales over the roots of the wings. Scutellum edged with silvery yellow scales broadened to patches at the sides. Pleuræ and

coxæ clothed with pale golden scales. Abdomen above dark metallic blue, the basal segment clothed with coarser lighter-colored greenish scales. Patches of golden scales at the sides of the sixth and seventh segments. Beneath pale golden, a broad median purple stripe on segments 3–7; eighth segment purple beneath, golden at the sides. Lateral cilia pale yellow except on the eighth segment and claspers, where they are dark.

Legs dark with purple lustre. The femora pale golden on the lower surface. Front tibiæ dull golden on the outside, the middle tibiæ on the inside. Middle legs with the third and part of the fourth segments of the tarsi silvery on the outer side. Hind legs with the fourth tarsal segment white.

Female.—Antennæ: second segment twice as long as the third and but slightly thicker, the basal half with a crest of erect scales. Palpi about two-thirds the length of the proboscis, four-jointed, stout, more or less laterally compressed, the third segment much thickened at the apex. Color violet-blue and purple with many pale golden scales, particularly on the sides of the second and third segments; apices of the segments pale mauve. Third segment much the longest, fourth shorter and stouter than the second, nearly cylindrical.

The abdomen is more or less greenish, passing into steel blue towards the tip. Segments 4–7 show golden spots at the sides and the sixth and seventh are finely margined behind with gold; eighth segment purplish spotted with gold. Femora and tibiæ as in the male. All the tarsi marked with white. On the first and second pair of legs the tarsi have the tip of the first, the second and the third, and part of the fourth segments white. On the hind legs the fourth and all but the tip of the fifth tarsal segments are white.

Length, 6–10 mm.

Type No. 9952, U. S. N. M.

Localities: Woodstock, Va. (F. C. Pratt), Morgantown, W. Va. (A. D. Hopkins), Washington, D. C. (J. Kotinsky), Plummer's Island, Md. (A. K. Fisher, W. V. Warner), River Township, Henderson Co., N. C. (J. L. Coker, Jr.), St. Louis, Mo. (A. Busck), Baton Rouge, La. (J. W. Dupree), Benoit, Miss. (H. S. Barber), Ringo, Indian Territory (A. N. Caudell), Skyland, Va. (Miss W. Pollock), Grandfather Mt., N. C. (F. Sherman).

13 ♂, 11 ♀. It should be noted that the markings on all the tarsi are clear white in the female. In the male the silvery markings of the middle tarsi are less distinct than the white on the hind tarsi and sometimes have to be carefully looked for. These markings are

uniform for either sex in all the specimens examined. We have seen no specimens of *Megarhinus* from North America with the front and middle tarsi entirely dark.

MEGARHINUS MOCTEZUMA new species

Male.—Head behind the eyes clothed with iridescent scales, at the sides and beneath silvery. Antennæ densely plumose; second segment longer than in *septentrionalis,* stout, laterally compressed, about as long as the three succeeding ones; heavily scaled along the crest. Palpi deep violet, on segments 2–4 scatteringly golden-scaled above and at the sides, entirely golden beneath, the apices pale lilac. Second and fourth segments of about equal length, the third longer, the fifth as long as the third and fourth together. Prothoracic lobes deep blue. Mesothorax dark brown on the disc with coppery scales; the median and lateral stripes of greenish blue scales; hind margin, scutellum and patches over the roots of the wings metallic blue. Pleuræ and coxæ silver-scaled with a tinge of yellow. Abdomen deep violet-blue, segments 6, 7 and 8 brilliant purple. First segment bright blue, more shining. Segments 2–7 with marginal golden spots, very narrow on the second segment and broadening to sixth and seventh where they become conspicuous patches. Segments 6, 7 and 8 margined behind with gold. Beneath pale golden, a narrow median blue line on segments 3–7; eighth segment entirely purple beneath. Lateral hairs pale yellow on segments 1–7, dark on the eighth and the genitalia. Legs dark with blue and purple lustre. Femora golden beneath. Front tibiæ on the outside, middle tibiæ on the inside, dull golden. Middle legs with the third tarsal segment white on the outside, a dash of silver at the base of the fourth segment. In the hind legs the fourth tarsal segment is white-ringed, black at its tip.

Female.—Antennæ: second segment somewhat longer than the third, slightly swollen basally, the basal two-thirds heavily clothed with purple scales. Palpi deep blue and purple, the segments pale at the apex; second and third segments with golden scales at the sides and beneath; second and third segments laterally compressed, the third slender at base, much thickened at apex; fourth segment stout and cylindrical, shorter than the second, the third twice as long as the fourth.

Abdomen greenish-blue merging into steel blue posteriorly, the eighth segment violet. Seventh segment finely margined with gold, eighth with terminal brush of bright yellow hairs. The hind angles

of segments 2–8 marked with gold. Beneath golden, a dark median line ends before the eighth segment.

Fore and middle legs with the second and part of the third tarsal segments silvery white; hind legs with the fourth and upper half of the fifth tarsal segments white. The white on the front tarsi is not so brilliant as in the two preceding species and in *trinidadensis*.

Length, 6–9 mm.

Type No. 9953, U. S. N. M.

Localities: Sonsonate and Izalco in Salvador, Rio Aranjuez near Puntarenas in Costa Rica (F. Knab), Antigua in Guatemala (D. G. Eisen).

16 ♂, 2 ♀. In the male the white of the middle tarsi has a tendency to become silvery and less distinct; sometimes the silver at the base of the fourth segment is absent. In three specimens the white of the third segment extends entirely around it. Although the tarsal markings are the same as those of the preceding species it can be easily separated by the coloration of the thorax and other details. Preparations of the male genitalia of the two species reveal specific differences.

MEGARHINUS TRINIDADENSIS new species

Male.—Head behind the eyes light blue with pearly lustre, at the sides and beneath silvery. Antennæ densely plumose, the second segment long and stout (stouter than in *moctezuma* and longer than in *septentrionalis*), its crest densely clothed with nearly flat purple scales. Palpi blue and purple, segments 2, 3 and 4 in certain lights largely silvery and iridescent and pale at the apices. Second segment slightly shorter than fourth, third longer; fifth as long as third and fourth together. Prothoracic lobes bright metallic blue. Mesothorax clothed with light green scales on the disc, light blue along the sides. Scutellum, ridge of scales over the root of wing and first abdominal segment brilliant greenish blue. Pleuræ and coxæ silvery.

Abdomen deep blue, purple on segments 6, 7 and 8. Beneath golden, a narrow black median line on segments 3–7, eighth segment violet. Lateral hairs pale, dark on eighth segment and genitalia.

Legs dark with blue and purple lustre; femora golden beneath; front tibiæ golden on the outside. Second segment of middle tarsi bluish-silvery on the outer side. In the hind tarsi the fourth and most of the fifth segments silver-scaled.

Female.—Antennal segments more elongate than in the preceding species. Second segment hardly stouter than the succeeding ones, slightly thickened basally, more than twice as long as the third, the basal ⅔ with a crest of dark erect scales. Palpi blue and purple with many golden scales, particularly at the sides and beneath; apices of the segments pale violet. Second and third segments laterally compressed, third enlarged at the apex, fourth nearly cylindrical and slightly shorter than second; third segment longest, not twice the length of second.

Abdomen greenish towards base, then steel blue, the eighth segment violet. Pale lateral spots, most conspicuous on segments 5, 6 and 7. Sixth and seventh segments finely margined behind with gold, eighth segment marked with gold. Abdomen golden at the sides and beneath, a narrow blue median line on segments 2–7.

Legs dark; the femora golden beneath; the middle and hind tibiæ dull golden upon the inside, the front tibiæ on the outside and passing over onto the first tarsal segment. Front and middle legs with the second and most of the third tarsal segments white; hind legs with the fourth and all but the tip of the fifth tarsal segment white.

Length, 6–10 mm.

Type No. 9954, U. S. N. M.

Locality: Trinidad (A. Busck, F. W. Urich).

3 ♀, 2 ♂. In the second male the markings of the middle tarsi are obsolete.

MEGARHINUS HAITIENSIS new species

Female.—Head above pearly blue, at the sides and beneath silvery. Antennæ: second segment twice as long as the third, hardly stouter, swollen basally, a crest of scales on the basal half. Palpi deep blue and violet with a few silvery scales, segments pale at the apex. Fourth segment cylindrical, slightly shorter than the second; third longest, nearly twice as long as the fourth. Prothoracic lobes bright blue. Mesothorax very dark blue on the disc, a median lighter blue stripe bounded at the sides by a patch of dull brown scales, the sides pale bluish. Scutellum, roots of the wings and first abdominal segment silvery blue and green-scaled. Pleuræ and coxæ silvery. Abdomen deep blue, the seventh and eighth segments violet. Sides silvery. Venter pale golden with a broad median blue area. Eighth segment with terminal bristles.

Legs dark blue and violet. Femora pale golden beneath. Hind tarsi only marked with white—the fourth segment, all but its tip.

Male.—Antennæ densely plumose; second segment stout, as long as the next three; its crest densely clothed with semi-erect scales.

Palpi blue and violet, segments 2, 3 and 4 with scattered golden scales and pale mauve apices. Second segment slightly shorter than fourth, third slightly longer; the fifth longer than the third and fourth together. Mesothorax with blue median line becoming green posteriorly and merging into the color of the scutellum. On each side of the blue median line a dull brown stripe from the front to the basal third. Well forward and close to the pale lateral stripe is a patch of very dark blue scales; behind this, along the basal half, is another stripe of dull brown. All these markings are obscured by a sprinkling of bright green scales. Over the roots of the wings are patches of brilliant blue scales. Abdomen blue, violet on the seventh and eighth segments. Light spots at the sides of some of the segments. Under side silvery with a median blue stripe, the eighth segment violet, the ninth with a silvery spot. Lateral hairs pale yellow, dark on the eighth and ninth segments.

Legs deep blue and violet. Under side of femora silvery or pale golden. Hind tarsi with the fourth segment mostly white.

Length, 7–9 mm.

Type No. 9955, U. S. N. M.

Locality: San Francisco Mts., Santo Domingo, West Indies (A. Busck).

3 ♂, 1 ♀. Bred from larvæ found in tree-holes. The male and female agree in tarsal markings and our specimens show no variation. The difference in the marking of the thorax of the female are due to abrasion, the description of the male shows the appearance in perfect specimens. This is the only species we have seen in which the tarsal markings are identical in the two sexes.

The description of *portoricensis,* as far as it goes, agrees with our species. The species is founded on a single male. Until we can compare specimens of both sexes from Portorico we assume the Santo Domingan form to be a distinct species.

MEGARHINUS GUADELOUPENSIS new species

Female.—Head pearly green and blue above, silvery at the sides and beneath. Antennæ very slender; the second segment not stouter and more than twice as long as the third, without crest of erect scales. Palpi slender, cylindrical, violet, the apices of the segments mauve; third segment laterally compressed, thickened at the apex, nearly twice as long as the fourth; fourth segment shorter than second. Prothoracic lobes bright blue. Mesothorax metallic green and blue, the two colors of about equal strength, the blue in a median line and at the sides. At the roots of the wings and on

the scutellum patches of bright, almost brassy, scales. Pleuræ and coxæ silvery with a yellowish tinge. Abdomen passing from dull greenish through blue and violet on the seventh segment to golden purple on the eighth. Eighth segment with dark bristles. Ventral surface entirely golden.

Legs deep violet, the femora golden beneath. Front tarsi unicolorous; middle tarsi with the second segment white on the outside (3–5 missing); hind tarsi with the fourth segment partly white.

Male.—Antennæ slender, sparsely plumose; the second segment but little stouter than the following ones, slightly longer than the third and fourth together, without crest of scales. Palpi long and slender; the second segment is a trifle shorter than the third, the third and fourth are of nearly equal length, the fifth longer than these two together. The coloration of the body is similar to that of the female. The legs are entirely dark without a trace of white on any of the tarsi.

Length, 5–7 mm.

Type No. 9956, U. S. N. M.

Locality: Guadeloupe, West Indies (A. Busck).

1 ♀, 1 ♂. Bred from larvæ found together in Bromelia water. The male is much denuded. Mr. Coquillet's characterization of the male *M. violaceus* is based on this specimen. The palpi are remarkably slender in this species, a particularly noticeable feature in the female. Another unique feature is the absence of erect scales on the second antennal segment in both sexes.

MEGARHINUS SUPERBUS new species

Megarrhina hæmorrhoidalis WILLISTON (not Fabricius), Biologia Centrali Americana, Diptera, v. 1, p. 224 (1901).

Megarhinus violaceus DYAR and KNAB (not Wiedemann), Journ. N. Y. Entomological Soc., v. XIV, pp. 178, 179 (1906).

Megarhinus violaceus (female) COQUILLETT (not Wiedemann), Technical Series No. 11, U. S. Dept. Agric., Bureau of Entomology, p. 14 (1906).

Male.—Head metallic blue and green with scattered coppery scales. Antennæ densely plumose; second segment as long as the following three and slightly thicker, its crest densely clothed with coarse, erect blue and golden scales. Palpi metallic—part violet-blue and coppery red, all but the last golden beneath. Third and fourth segments of equal length, the second slightly shorter, the fifth as long as the third and fourth together.

Prothoracic lobes bright blue. Mesothorax denuded on the disc, the remaining scales, particularly towards the sides and behind,

golden-green and olivaceous, the extreme lateral margins bright blue; hind margin bright green. Patches over the roots of the wings brilliant blue. Scutellum silvery blue. Pleuræ and coxæ silvery white. Abdomen: first segment silvery, a patch of blue in the middle; second segment green, the following ones steel blue and purple to deep golden; the gold begins on the fourth segment and is diffused over the entire surface of the much dilated sixth and seventh segments; eighth segment violet; genitalia covered with deep blue scales. Sixth segment with a few reddish hairs at the hind angles; seventh and eighth segments with lateral fringes of brilliant red hairs, particularly ample on the seventh segment; the preceding segments with the usual scattered, pale yellow, lateral hairs. Beneath golden along the sides, the median area steel blue; eighth segment entirely blue. Legs steel blue and reddish purple. Femora and hind tibiæ golden beneath.

Female.—Coloration of head and thorax as in the male. Antennæ: second segment 1½ times as long as the third, hardly stouter, a small crest of erect scales on the basal half. Palpi violet blue and coppery red, golden beneath; fourth segment longer than second, third much longer than fourth.

Abdomen: first segment bright silvery at the sides, pale blue in the middle; second segment green, the third blue and purple, the succeeding ones purplish red and bright coppery—the latter shade predominating on the sixth, seventh and eighth segments; front angles of segments 2–8 bright blue; hind angles of segments 2–6 broadly golden. No lateral tufts—a few red hairs at the sides of the seventh segment. Beneath entirely pale golden.

Legs steel blue and coppery red. Femora and hind tibiæ golden beneath. On the middle pair of legs the second tarsal segment is marked with silvery blue on the inside, visible only in certain positions.

Length, 4–6 mm.

Type No. 9957, U. S. N. M.

Localities: Trinidad (F. W. Urich), Frontera, State of Tabasco, Mexico (Townsend).

2 ♂, 1 ♀. The Mexican specimen, a male, shows none of the golden scales on the abdomen which is mostly blue and purple. In the other specimen the golden scales have the appearance of being loosely attached and easily rubbed off. Mr. Urich's two specimens were bred from Bromelias, where the larvæ prey on those of *Wyeomyia.* The male was but recently received. The female

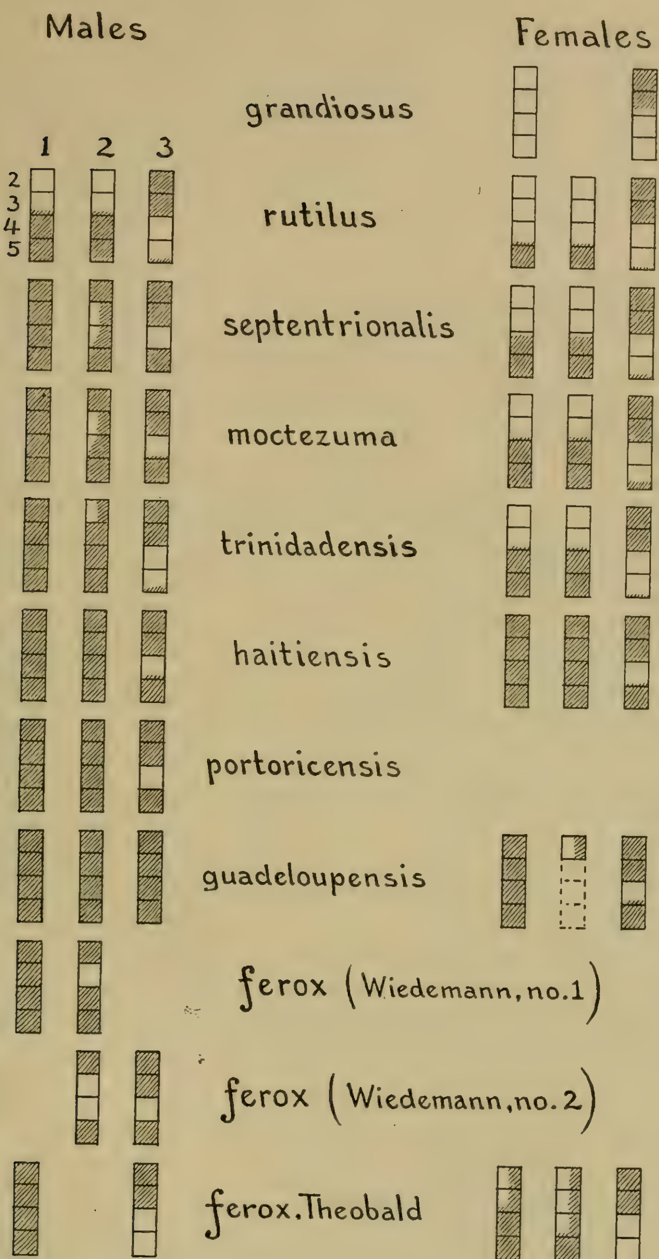

FIG. 28. Megarhinus—diagram of tarsal markings.

formed the basis for Mr. Coquillett's diagnosis of *M. violaceus* and we have characterized the larva under that name.

It is evident that the three male specimens reported from Atoyac in the state of Vera Cruz (Mexico) by Williston, and doubtfully referred by him to *hæmorrhoidalis,* belong to the present species. His criticism of Wiedemann's description of *hæmorrhoidalis* and his statement that the red hairs of the tuft "are confined to the tip of the sixth and the sides of the seventh segments" proves this beyond a doubt.

The following list comprises the American species of Megarhininæ described up to the present:

Genus ANKYLORHYNCHUS Lutz

violaceus Wiedemann .... Brazil.
    ?purpureus Theobald.
trichopygus Wiedmann .... Brazil.
neglectus Lutz .... Brazil.

Genus MEGARHINUS Robineau-Desvoidy

septentrionalis Dyar and Knab .... Atlantic States.
    ferox Walker (not Wiedemann).
    rutila Coquillett (in part).
    portoricensis Coquillett (not von Röder).
rutila Coquillett .... Florida.
haitiensis Dyar and Knab .... Santo Domingo.
portoricensis von Röder .... Porto Rico.
guadeloupensis Dyar and Knab .... Guadeloupe.
    violaceus ♂ Coquillett (not Wiedemann).
Species .... St. Vincent.
    portoricensis Williston (not von Röder).
trinidadensis Dyar and Knab .... Trinidad
longipes Theobald .... Mexico.
grandiosa Williston .... Mexico.
moctezuma Dyar and Knab .... Central America.
    ?species Osten Sacken.[1]
superbus Dyar and Knab .... Mexico, Trinidad.
    hæmorrhoidalis Williston (not Fabricius).
    violaceus Dyar and Knab (not Wiedemann).
    violaceus ♀ Coquillett (not Wiedemann).
hæmorrhoidalis Fabricius .... Guiana.
    separata Lynch-Arribálzaga.
theobaldi Dyar and Knab .... Brazil.
    ferox Theobald (not Wiedemann).
wiedemanni Dyar and Knab .... Brazil.
    ferox Wiedemann (not von Humboldt).
ambiguus Dyar and Knab .... Brazil.
    ferox Wiedemann (not Wiedemann).
mariæ Bourroul .... Brazil.
solstitialis Lutz .... Brazil.
lynchi Dyar and Knab .... Argentine.
    hæmorrhoidalis Lynch-Arribálzaga (not Fabricius).

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[1] Biologia Centrali-Americana, Diptera, VI, p. 6 (1886).

A CONTRIBUTION TO THE KNOWLEDGE OF SOME SOUTH AMERICAN HYMENOPTERA, CHIEFLY FROM PARAGUAY

By C. SCHROTTKY[1]

MONOBIA Saussure

On January 7, 1905, I observed a female of the solitary wasp *Monobia angulosa* Saussure var. *cingulata* Bréthes, entering a small hole in the ground. When this hole was carefully opened it showed a vertical channel widening a little beneath, 4 cm. long, terminating in a globular cell 12 mm. in diameter. In this cell nine larvæ of a noctuid were packed close together. They were of a green color with white lateral stripes and measured 10–12 mm. in length. Under these larvæ, on the bottom of the cell, was found the small whitish larva of the wasp, about 2.5 mm. long, apparently but a few days old.

MEGACILISSA Smith

On January 12, at 4 o'clock in the morning, a male of *Megacilissa matutina* entered my room, attracted doubtless by the shining lamp. It was still night when I was surprised by this singular visitor. *Megacilissa eximia* Smith had been observed on the wing after sunset and before sunrise, but never after seven o'clock in the morning. From this new record of a very early hour one may conclude that on warm nights the Megacilissæ are flying all night long, which may explain their comparative rarity in collections. They fly very rapidly and it is not easy to catch them, but they are not at all rare. If one knows their food-plants, they may at times be seen by thousands, as I found in Brazil in the case of *M. eximia* and here with *M. matutina*. I do not know whether there have been observed any other South American bees with nocturnal habits. [Compare the account of *M. yarrowi*, Cresson, in *Annals and Magazine of Nat. History*, December, 1899, p. 411.—T. D. A. C.]

FRIESEA Schrottky

In Rev. Mus. Paul., v (1903), p. 418, and T. XIV, fig. 2 *a–e*, I published a new genus of Panurgidæ, *Friesea*. Prof. T. D. A. Cockerell kindly informed me that this name was preoccupied in 1895

[1] With notes by Professor T. D. A. Cockerell, signed T. D. A. C.

by Prof. K. W. von Dalla Torre and suggested to me to rename my genus. I, therefore, propose to change it to

PARAFRIESEA n. nom.

Type, Parafriesea brasiliensis. (*Friesea brasiliensis* Schrottky.)

PROSOPIS Fabricius

Early in November, 1904, I took a specimen of *Prosopis* on flowers of *Petroselinum sativum.* As at this time the white Mimosæ were flowering, I spent most of my time in hunting for the beautiful *Pepsis, Eumenes, Montezumia,* etc., visiting these shrubs. Only at the end of December, when the blossoming time of the Mimosa was over, did I remember the *Prosopis* found on the *Petroselinum* and began to watch this plant a little more carefully. In a few days I had the good fortune to obtain about fifty specimens of *Prosopis,* and nearly every day during January I added to the number. Now as this most attractive plant has ceased to flower I think it useful to record the species obtained. The fifteen species may be separated by the following table:

1. The first recurrent nervure enters the first cubital cell before its apex; wings with a fuscous cloud............................1. *petroselini.*
   The first recurrent nervure interstitial or enters the second cubital cell; sometimes it enters the first cubital cell but in that case the wings have no fuscous cloud.. 2.
2. Scutellum and postscutellum *yellow*........................2. *polybioides.*
   Scutellum *yellow,* the postscutellum *black*............................ 3.
   Scutellum and postscutellum black or only the sides of the scutellum alone have a yellow spot... 8.
3. Wings with a fuscous cloud.. 4.
   Wings hyaline.. 5.
4. Abdominal segments *without* fasciæ of white hairs.........3. *guaranitica.*
   Abdominal segments *with* fasciæ of white hairs..............4. *paulistana.*
5. Sides of the clypeus *ferrugineous*..................................... 6.
   Clypeus totally *yellow*....................................5. *femoralis.*
6. Abdomen *black*.. 7.
   Abdomen with the first segment *ferrugineous*...................7. *rivalis.*
7. Legs *black,* the tibiae with the base yellow..................6. *gracillima.*
   Legs *fulvous*.............................6a. *gracillima* var. *paranensis.*
8. Scutellum on each side with a *yellow* spot......................8. *tricolor.*
   Scutellum *black*.. 9.
9. Clypeus *yellow*...10.
   Clypeus *ferrugineous*.................................10. *paraguayensis* ♀.
   Clypeus *yellow* with the sides black.......................9. *itapuensis* ♀.
10. First joint of antennae *black*............................9. *itapuensis* ♂.
    First joint of antennae *yellow, fulvous* or *ferrugineous*...............11.

11. Metathorax more or less truncate....................................12.
Metathorax rounded, the horizontal and vertical parts not separated, uniformly punctured..............................10. *paraguayensis* ♂.
12. Wings hyaline..13.
Wings with a fuscous cloud............................11. *cockerelli.*
13. A yellow spot above the clypeus...................................14.
No yellow spot above the clypeus......................12. *culiciformis.*
14. Smaller; spot above the clypeus pentagonal; the metathorax less distinctly sculptured..15.
Larger; spot above the clypeus almost rectangular; the metathorax more strongly sculptured, the first recurrent nervure interstitial....13. *tristis.*
15. The yellow color of the clypeus and the face at its side, *not* interrupted; punctures on mesonotum scattered, the first recurrent nervure interstitial ....14. *xanthocephala.*
The yellow color of the clypeus and the face on its side interrupted by a narrow black line; punctures on mesonotum very dense, first recurrent nervure received by the first cubital cell................15. *longicornis.*

1. PROSOPIS PETROSELINI new species

Male.—Length, 6½ mm.; abdomen, 1½ mm. wide; wings, 4½ mm.; antennæ, 2¼ mm. Black; the clypeus, a trapeziform spot above it, the face at the sides of the clypeus, and the inner orbits of eyes nearly to their summit pale yellow; antennæ ferrugineous; scutellum, the tubercles of the thorax and a small spot upon the tegulæ bright yellow; apical margin of the first abdominal segment on the sides with a line of small white hairs, the apical margin of the other segments fringed with inconspicuous white hairs. The tibiæ of the anterior legs are honey-colored, with a black longitudinal stripe outside, extreme apex of the femora and base of the tarsi honey-colored, the rest fuscous. Middle legs: tibiæ at their extreme base and apex, pale ferrugineous; hind legs with the tibiæ at their base pale yellow about one-fourth of their length; the rest black. Wings hyaline, with a fuscous cloud occupying the apical half of the median, the first cubital and the whole marginal cell, extending beyond to the apex of the wing.

Head densely punctured; pronotum with two indistinct ferrugineous spots; mesonotum coarsely punctured; pleuræ with scattered, deeply impressed punctures, metathorax opaque, truncate, covered with very small pale hairs; the basal space enclosed by distinct carinæ, smooth, in the middle with three short longitudinal carinæ; first abdominal segment in the middle strongly punctured, the punctures becoming finer towards the sides; second segment much more finely punctured, deeply depressed at its base; the punctures on the following segments are not more distinguishable. Wings: The second

cubital cell extremely narrow; the first recurrent nervure is received by the first cubital cell a little before its apex.

Taken in December, 1904, on *Petroselinum sativum* at Villa Encarnación.

2. PROSOPIS POLYBIOIDES new species

Female.—Length, 7½ mm.; abdomen, 1¾ mm. wide; wings, 5½ mm.; antennæ, 2 mm. long. Black; the clypeus in the middle, a patch above it, the face at the sides of the clypeus, the inner orbits of the eyes extending upwards nearly to their summit, and the three basal joints of the antennæ dark orange-red; the sides of the clypeus and the rest of the antennæ, except the apex of the last joint which is ferrugineous, are fuscous; the tubercles of the thorax and the anterior margin of the pronotum are dark orange-red; the hind margins of the tubercles are followed by a semicircular pale yellow line; the scutellum and postscutellum are bright yellow. Abdomen: First segment on its apex with a narrow fascia of white hairs laterally; apical margin of the second segment and the rest of abdomen covered with very fine yellowish hairs, the segments 2–5 with their apical margins pale brown. Legs: The inner side of the anterior tibiæ and the apical half of the anterior femora are honey-colored; the posterior tibiæ at their base are pale yellow. Tegulæ brownish; wings hyaline, with a very dark fuscous cloud that occupies the apex of the median, the first cubital and the marginal cells, and extends to the apex of the wing.

The head is densely covered with fine punctures; the mesonotum is coarsely punctured; the pleuræ with scattered deeply impressed punctures; metathorax truncate, covered with pale hairs, the basal space coarsely rugose. Abdomen: First segment shining, finely punctured, the following segments opaque. Wings: The second cubital cell receives the first recurrent nervure just in the basal angle and the second recurrent nervure a little before its apex.

This species has a striking resemblance to *Polybia scutellaris* White, but is, however, smaller.

Taken December 30, in Villa Encarnación, Paraguay.

NOTE:—The coloration of this species is variable. The extension of the orange red of the head is sometimes much reduced so that the base of the clypeus, the patch above it and the third joint of the antennæ become fuscous. In one specimen the face at the sides of the clypeus is yellow. The same thing occurs with the last joint of abdomen. The margin of the pronotum has sometimes only two orange-red spots and even these sometimes disappear and the pro-

notum is unicolorous black; the tubercles of the thorax are sometimes dark fuscous and sometimes black. The semicircular pale yellow line exists only in the first described specimen. The honey-color of the anterior tibiæ is sometimes reduced to the basal half, sometimes it disappears entirely. One of the specimens has a rather distinct fascia of white hairs on the apical margin of the second abdominal segment, and in another the fine hairs on the abdominal segments are whitish. But as the color of the scutellum and the postscutellum is *always* bright yellow, the species may be easily distinguished from all others by this character and by the comparatively larger size.

To judge from the few specimens I have seen, the darker form seems to be the commoner, while the other is perhaps merely a form immaturely colored. The morphological structure is identical in both forms.

The species appears to be rare.

3. PROSOPIS GUARANITICA new species

Male.—Length, 6 mm.; abdomen, 1½ mm. wide; wings, 4 mm.; antennæ, 2¼ mm. long. Black; the clypeus, a nearly triangular spot above it, the face on the sides of the clypeus, the inner orbits of the eyes reaching upwards nearly to their summit, the tubercles of the thorax, and the scutellum, are bright yellow; the antennæ are ferrugineous in front and fuscous above; pronotum with two orange-red spots; tegulæ brownish, with a minute yellow spot; the apical margins of the abdominal segments are fringed with minute white hairs, but they form no conspicuous fasciæ; the whole anterior tibiæ and tarsi, the intermediate tibiæ at their base and apex and the posterior tibiæ at base are yellow; the wings are hyaline, with a fuscous cloud occupying the marginal cell and extending to the apex of the wing; in the first cubital cell as well as in the apex of the median cell the cloud becomes less pronounced.

Head densely punctured; mesonotum and pleuræ covered with deeply impressed punctures; metathorax truncate, the truncation in the middle depressed and covered with radiating plicæ; basal space in the middle with two low longitudinal carinæ, at the sides of which is a smooth space, surrounded by a distinct oval impression. The first abdominal segment is densely and deeply punctured; second segment with a deep basal depression, covered with fine and very numerous punctures except on its apex. The neuration of the wings is the same as in *P. polybioides*.

Taken frequently in December, 1904, and January, 1905, in Villa Encarnación, Paraguay.

NOTE:—The coloration of this species scarcely varies; the two orange-red spots on the pronotum alone being sometimes ferrugineous or yellowish; in the latter case sometimes confluent, and forming a more or less extended transverse line.

4. PROSOPIS PAULISTANA new species

Male.—Length, 5½ mm.; abdomen, 1⅓ mm. wide; antennæ, 3½ mm.; wings, 5 mm. Black; with yellow markings: the clypeus, a spot above it, the sides of the face, the inner orbits of the eyes, the collar, the tegulæ in front, the tubercles of the thorax, the scutellum, the apex of the anterior femora, the tibiæ in front and inside, the tarsi, the posterior tibiæ at apex and the tarsi (the second pair of legs is wanting); the rest of the legs dark brown. The abdominal segments at their apex fringed with distinct fasciæ of white hairs. The wings are hyaline, with a faint cloud in the marginal cell extending to the apex of the wing and becoming less distinct in the first cubital and the apex of the marginal cell.

Head densely punctured, mesonotum with deep, large, and dense punctures, those on the pleuræ deep but scattered. Metanotum truncate, the truncation covered with pale hairs, the basal space shining, small, with a longitudinal median furrow and a trapezoidal smooth space on each side; the apex surrounded by short and low radiating striæ. Abdomen densely covered with fine punctures that become gradually smaller on each segment, being hardly distinguishable from the fourth segment to the apex. The second segment near its base with a deep transversal depression. The neuration of the wings as in *P. polybioides*.

Habitat.—State of S. Paulo, Brazil, October 10, 1901, described from a single specimen.

NOTE:—The abdomen being retracted the length is given approximately.

5. PROSOPIS FEMORALIS Schrottky

1903. *Prosopis femoralis* SCHROTTKY, Rev. Mus. Paul., v, p. 339, n. 2, male (nec female!).

Male.—Length, 5 mm.; abdomen, 1⅓ mm. wide; wings, 4 mm.; antennæ, 2 mm. long. Black; the clypeus, a pentagonal spot above it, the face at the sides of the clypeus, the inner orbits of the eyes, the two basal joints of the antennæ in front, the collar, the tubercles of the thorax, the tegulæ in front, the base of the costal nervure of the wings, the scutellum and the greater part of the legs are yellow; the posterior femora alone are wholly fuscous, the intermediate and

anterior femora behind and the apical part of the posterior tibiæ being more or less fuscous; the flagellum of the antennæ is ferrugineous in front and fuscous above. The tegulæ behind are pale brown. Wings hyaline, with fuscous nervures. The apex of the abdomen is ferrugineous below; the apical margins of the second and third segments are also sometimes ferrugineous; the second segment has sometimes a minute fascia of white hairs on the sides.

Head densely, thorax coarsely punctured; the pleuræ are covered with scattered deep punctures and short yellowish hairs; the metathorax is truncate, the truncation with a longitudinal low depression and fine radiating striæ towards the margin; the basal space is punctured, a little raised, with six longitudinal furrows, the two median converging forming a **V**, the two exterior small and less distinct. First abdominal segment is covered with fine punctures, the second segment has a deep transverse depression near its base, from whence to its apex it is very finely punctured; the rest of the abdomen is smooth and shining. Both recurrent nervures are nearly interstitial; the first recurrent joins the cubitus just behind the first transverse cubitus, the second before the second transverse cubitus.

Taken at Villa Encarnación, December 27 and 28, 1904.

This species seems to be very similar to *P. rugosa* Smith, judging from his description. The differences are, however, in the color of the legs, the structure of the basal space of the metathorax, and of the abdominal segments. Some of my specimens have no fasciæ of white hairs on the abdominal segments, nevertheless it may be but the Southern form of *P. rugosa* Smith.

The original description, in Rev. Mus. Paul, v, p. 339, treats of female and male; this is a mistake, both specimens described there being males. I think that by direct observations it may be found that *gracillima* is the female of this species, but for the present it seems more convenient to consider them different species.

6. PROSOPIS GRACILLIMA Schrottky

1903. *Prosopis gracillinea* (laps.!) SCHROTTKY, Rev. Mus. Paul., v, p. 340, n. 4, T. XII, fig. 1.

Female.—Length, 6 mm.; abdomen, 1⅓ mm. wide; wings, 4½ mm.; antennæ, 2 mm. Black; the middle of the clypeus, a rectangular small spot above it, the face on each side of the clypeus, the inner orbits of the eyes, the collar, the tubercles of the thorax, the tegulæ in front, the scutellum and the base of the tibiæ, are yellow; the mandibles, the labrum and the sides of the clypeus, are fuscous;

the antennæ beneath are ferrugineous, but above they are fuscous; the tarsi are fuscous, but the base of the front pair is ferrugineous; hinder part of the tegulæ pale brown; the wings hyaline and iridescent, the nervures dark brown. Abdomen with the apical margins of the segments covered with fine white hairs, forming distinct fasciæ laterally.

Head densely covered with fine punctures, those on the mesonotum deeper and stronger, the pleuræ with the punctures smaller and more scattered than on the mesonotum; on the yellow scutellum are a few, small, scattered punctures. The truncation of the metathorax is rather densely covered with pale hairs, the basal space with shallow furrows; one enclosing an oval space, truncate at the base in the middle, from the apex of which two others extend backwards to the sides; two others, but less distinct, are found on each side of the oval space diverging behind so that the whole appearance is radiated. The abdomen is smooth and shining, without any distinguishable punctures. Both recurrent nervures are interstitial.

Taken at Villa Encarnación, November 7, 1904.

Another specimen from the same place, taken December 20, 1904, has the mandibles, the labrum, the sides of the clypeus and a spot between the antennæ not fuscous but ferrugineous, as described for the type which came from S. Paulo, Brazil. The legs, too, are not black but brown, except the base of the tibiæ which are yellow. Notwithstanding these differences, I do not think they form two different species, but rather that the form with the brown or even fulvous legs belong to the second generation or to a variety of this species, especially as there are in two specimens some other differences in the coloring. I give their full description pending larger and better series before deciding definitely as to whether these forms belong to *one* or to *various* species.

6a. PROSOPIS GRACILLIMA var. PARANENSIS new variety

Female.—Length, 6 mm.; abdomen, 1½ mm. wide; wing, 4½ mm.; antennæ, 2 mm. Black; the middle of the clypeus, the face on each side of it, the inner orbits of the eyes, the collar, the tubercles of the thorax, the tegulæ in front and the scutellum are yellow; the mandibles, the labrum, the sides of the clypeus and the hind orbits to the middle of the eyes, are ferrugineous. Above the clypeus is a ferrugineous spot with yellow centre; the antennæ are ferrugineous beneath, fuscous above; the hinder parts of the tegulæ and a small cuneate spot in front of the tubercles, are brown; the legs, except

the base of the posterior tibiæ which is yellow, are fulvous without any black. The abdominal segments at their apical margins are clothed with fine white hairs, which form indistinct fasciæ laterally. The wings are hyaline, with brown nervures.

Head densely covered with fine punctures; mesonotum with the punctures less dense but deeper and stronger; the pleuræ are covered with minute pale hairs and a few scattered but rather strong punctures. The base of the metathorax has irregular longitudinal folds or wrinkles, the truncation covered with pale hairs. The abdomen is impunctate, smooth and shining. Both recurrent nervures are interstitial.

Taken in Villa Encarnación, December 26 and 28, 1904.

7. PROSOPIS RIVALIS new species

Female.—Length, 6 mm.; abdomen, 1½ mm. wide; wing, 4½ mm.; antennæ, 2 mm. long. Black; the clypeus, except the sides which are ferrugineous, is almost rectangular, a spot above it, the face on each side of the clypeus, the inner orbits of the eyes nearly to their summit, the collar, the tubercles of the thorax, the tegulæ in front, the scutellum, and the extreme base of the anterior and the posterior tibiæ are yellow, the mandibles, the labrum, the antennæ, the legs and the first abdominal segment, except a black patch on the apex of the dorsal face, are ferrugineous. Wings hyaline, the nervures fuscous.

Head densely covered with fine punctures, the mesonotum with less dense but stronger punctures; the pleuræ have very fine, scattered punctures; the metathorax is truncate, the truncation covered with very fine pale hairs, and divided longitudinally by a shallow furrow, the basal area is longitudinally plicate, the sides covered with dense fine punctures; the abdomen is impunctate and polished, the apical margins of segments 2–5 being brown; near the base of the second segment is a low transverse depression.

Taken at Villa Encarnación on January 25, 1905.

8. PROSOPIS TRICOLOR new species

Male.—Length, 6 mm.; abdomen, 1¼ mm. wide; wings, 4 mm.; antennæ, 2 mm. long. Black; the clypeus, a pentagonal spot above it, the face on each side of the clypeus, the inner orbits of the eyes nearly to their summit, the basal joint of the antennæ in front, a transverse line on each side of the pronotum joining the tubercles of the thorax, and the tubercles, a spot in front of the tegulæ, a spot on each side

of the scutellum, and the base of the tibiæ, are yellow; the mandibles, the rest of the antennæ and the rest of the legs, the first abdominal segment, except a large black patch on the dorsal face, are ferrugineous; the sixth ventral plate and sometimes the fifth dorsal plate are also ferrugineous; the posterior parts of the tegulæ are fulvous. Wings hyaline, with brown nervures.

Head and mesonotum densely covered with fine punctures, those on the scutellum more scattered; the pleuræ are covered with a few, shallow, almost imperceptible punctures; the truncation of the metathorax is covered with very fine whitish hairs, the basal space sculptureless, impunctured, with only a short, shallow, transverse depression near its base; the abdomen is smooth, impunctured, the apical margins of the segments pale brownish, from the second segment to the apex it is covered with inconspicuous yellowish hairs. Both recurrent nervures are interstitial.

Taken at Villa Encarnación, January 9 and 11, 1905.

[Distinguished from *P. arsenica*, Vachal, by the smooth impunctured abdomen, the rather larger size, etc.—T. D. A. C.]

9. PROSOPIS ITAPUENSIS new species

Female.—Length, 4–5 mm.; abdomen, 1 mm. wide; wings 3½ mm.; antennæ, 1½ mm. long. Black; the middle of the clypeus, the face on each side of it, the inner orbits of the eyes extending nearly to summit, the tubercles of the thorax, the anterior tibiæ in front, and the base of the intermediate and posterior tibiæ, are yellow; the mandibles are ferrugineous; the labrum is fuscous; the sides of the clypeus are black; the basal joint of the antennæ is black, the rest of the antennæ being ferrugineous in front, but fuscous above; the tarsi are ferruginous; the tegulæ are brown, with a minute yellow spot in front. Wings hyaline, the nervures nearly black.

The head and mesonotum are densely covered with very fine punctures; scutellum is long, about one and one-half times as long as wide, and covered with fine scattered punctures; pleuræ opaque, the punctures rather finer than those on the head and more scattered; the basal area of the metathorax is smooth, opaque with a shallow groove in the middle near the base which is parted longitudinally by a small low carina, the truncation is parted longitudinally by a low furrow which itself divides above in two branches forming thus a Y; the abdomen is smooth. The first recurrent nervure joins the cubitus a little before the first transverse cubitus, the second re-

current nervure just before the second transverse cubitus or the angle of the second cubital cell.

Male.—Length, 4 mm.; abdomen, 4/5 mm. wide; wing, 3½ mm.; antennæ, 2 mm. long. Black; the mandibles, labrum, clypeus, except a very fine black line on each side, the face on each side of the clypeus, the inner orbits of the eyes, the tubercles of the thorax, the apex of the anterior femora, the anterior tibiæ in front, and the middle and hind tibiæ at base, are yellow; the basal joint of the antennæ is black, the second joint yellowish, the rest of the antennæ beneath fulvous but above fuscous; the abdomen is black with the apex ferrugineous.

Named after "Itapúa," the ancient Guarané-name of Villa Encarnación. Male and female taken *in copula* on January 26, 1905. A common species during December and January.

The female has the same coloring as *variolosa* Sm. but differs from it by its smaller size, less distinctly sculptured thorax and abdomen and by the cheeks not being flat.

[Distinguished from *P. palmaris,* Vachal, by the apparently weaker sculpture of the thorax, especially the metathorax, the basal area of which is "almost reticulated" in *palmaris.*—T. D. A. C.]

10. PROSOPIS PARAGUAYENSIS new species

Female.—Length, 5 mm.; abdomen, 1 mm. wide; wings, 3¾ mm.; antennæ, 1¾ mm. long. Black; the mandibles, the labrum, the clypeus, the antennæ, the legs and the greater part of the first abdominal segment, are ferrugineous; the face on each side of the clypeus, the inner orbits of the eyes to three-quarters of their height, the tubercles of the thorax, the tegulæ in front and the extreme base of posterior tibiæ, are yellow; rest of the tegulæ brown. Wings hyaline, splendidly iridescent, with fuscous nervures.

Head densely punctured, the mesonotum, scutellum and pleuræ covered with fine, not very dense, punctures; metanotum rounded; there is no sharp division between the horizontal and vertical parts, while one cannot speak of a basal area, it being apparently absent, whole metathorax being uniformly covered with very dense rugose punctures. The abdomen is highly polished, the first segment covered with very fine, scattered punctures. The first recurrent nervure is received by the first cubital cell a little before its apex; the second recurrent nervure is almost interstitial with the second transverse cubitus.

Male.—Length, 4 mm.; abdomen, ¾ mm. wide; wing, 3 mm.;

antennæ, 1½ mm. long. Black; the mandibles, the labrum, the clypeus, a quadrate spot above it, the face at the sides of the clypeus, the inner orbits of the eyes, and the tubercles of the thorax, are yellow; the antennæ are fulvous beneath, a little darker above; the legs are fulvous, but with a large dark brown spot on the posterior femora and tibiæ. The first abdominal segment beneath is totally, and above on the apical margin, rufous. The sculpture, the neuration of the wings, etc., as in the female.

Females, December 27 and January 25.

Males, December 17, 25, 26, 27, 29, 1904; January 12 and 26, 1905.

A rather common species.

Its systematical position is near *amazonica* Gribodo.

11. PROSOPIS COCKERELLI new species

Male.—Length, 6 mm.; abdomen, 1½ mm. wide; wing, 4½ mm.; antennæ, 2¼ mm. long. Black; the clypeus, a pentagonal spot above it, the face on each side of the clypeus, the inner orbits of the eyes, the tubercles of the thorax, the anterior tibiæ in front, and the posterior tibiæ at extreme base, are yellow; the mandibles, the labrum, and the antennæ beneath are ferrugineous; the antennæ above are dark fuscous; the tarsi, the tegulæ and the apical margins of the abdominal segments are brown. Wings hyaline, with a fuscous cloud that occupies the whole radial cell, and extending beyond it towards the apex of the wing, enclosing first cubital and the apex of the median cell; the nervures are black.

Head densely covered with fine punctures; the mesonotum and the scutellum with dense strong and deep punctures; those on the pleuræ are also deep and strong but scattered; the metathorax is truncate, the basal area divided by a broad, longitudinal furrow, with a few strong irregular punctures, and at each side with an oblique furrow; the truncation is rugose but shining; the first abdominal segment is strongly punctured, shining, the second segment near its base with a deep transverse depression, from whence to the apical margin covered with very fine, almost inconspicuous punctures; segments 3–5 are thinly covered with very fine yellowish hairs. Both recurrent nervures almost interstitial.

Taken at Villa Encarnación, January 4, 1905.

Named in honor of Prof. T. D. A. Cockerell, of Boulder, Colo.

12. PROSOPIS CULICIFORMIS new species

Male.—Length, 5 mm.; adbomen, 4/5 mm. wide; wing, 3½ mm.; antennæ, 2 mm. long. Black; the mandibles, the labrum, the clypeus, the face on each side of it, the inner orbits of the eyes reaching nearly to summit, the two basal joints of the antennæ beneath, the tubercles of the thorax, the anterior tibiæ in front, the intermediate and posterior tibiæ at base and apex, are yellow; the rest of the antennæ ferrugineous beneath, darker above; the tarsi are fulvous; while the tegulæ are pale brown. Wings hyaline and splendidly iridescent, their nervures fuscous. The apex of the abdomen is ferrugineous.

Head and mesonotum covered densely with fine punctures, the pleuræ with very fine whitish hairs and interspersed fine punctures, those on the scutellum scattered; the metathorax is truncate, its basal area limited on each side by an oblique furrow, opaque, uniformly punctured; the abdomen impunctured, the second segment without transverse depression; the first recurrent nervure is interstitial, the second nearly so.

Taken at Villa Encarnación, January 10 and 19, 1905.

13. PROSOPIS TRISTIS new species

Male.—Length, 5 mm.; abdomen, 1¼ mm. wide; wing, 3¾ mm.; antennæ, 2 mm. long. Black; the mandibles, the labrum, the clypeus, a rectangular spot above it, the face on each side of the clypeus, the inner orbits of the eyes, the two basal joints of the antennæ, the tubercles of the thorax, the anterior femora at apex, the anterior tibiæ total, the intermediate and posterior tibiæ at base, are yellow; the rest of the antennæ ferrugineous beneath but a little darker above; the tarsi fulvous, the tegulæ brown. Wings hyaline, faintly darkened towards apex, the nervures brown. The apical margins of the abdominal segments are fuscous.

Head densely covered with fine, mesonotum with strong, punctures; the punctures on the scutellum are more scattered, on the pleuræ fine and scattered; the metathorax is truncate, the basal area rough with a few longitudinal plicæ; the first abdominal segment is polished, but covered with very fine, almost inconspicuous, scattered punctures, the rest of abdomen being a little more opaque. Both recurrent nervures are interstitial.

Taken at Villa Encarnación, December 22, 1904.

14. PROSOPIS XANTHOCEPHALA new species

Male.—Length, 4½ mm.; abdomen, ⅘ mm. wide; wing, 3½ mm.; antennæ, 2 mm. long. Black; the labrum, the mandibles, the clypeus, a pentagonal spot above it, the face on each side of the clypeus, the inner orbits of the eyes, the two basal joints of the antennæ beneath, the tubercles of the thorax, from there an oblique line to the anterior margin of the pronotum, a minute spot on the tegulæ, the apical half of the anterior femora, the anterior tibiæ and tarsi, the intermediate femora in front, the intermediate tibiæ, except a small fuscous spot behind, the posterior tibiæ at their base and apex, and the intermediate and posterior tarsi, are yellow; the rest of the antennæ ferrugineous beneath, fuscous above; the tegulæ are brownish. Wings hyaline, the nervures brown. The apex of the abdomen is ferrugineous.

Head densely covered with fine punctures, the mesonotum with fine and scattered punctures, the scutellum with only a few fine dispersed punctures; the pleuræ are semiopaque; the metathorax is truncate, the basal area with a few low longitudinal plicæ; the abdomen semiopaque, the second segment without transverse depression. Both recurrent nervures are interstitial.

Taken at Villa Encarnación, December 29, 1904.

15. PROSOPIS LONGICORNIS new species

Male.—Length, 4½ mm.; abdomen, ¾ mm. wide; wing 3¼ mm.; antennæ, 2⅕ mm. long. Black; the mandibles, the labrum, the clypeus, a pentagonal spot above it, the face on each side of the clypeus, the inner orbits of the eyes, the two basal joints of the antennæ in front, the tubercles of the thorax, the apical half of the anterior femora, the anterior tibiæ and tarsi, the intermediate and posterior tibiæ at their base, and the intermediate and posterior tarsi, are yellow; the rest of the antennæ ferrugineous beneath, fuscous above. Wings hyaline, the tegulæ brown, the nervures dark brown.

Head and mesonotum densely covered with fine punctures, those on the scutellum and on the pleuræ fine and scattered; the metathorax is truncate, the basal area opaque, granular, in the middle with a few groove-like impressions; the abdomen semiopaque, the second segment with a shallow transverse depression near its base. The first recurrent nervure enters the first cubital cell before its apex, the second recurrent being interstitial.

Taken at Villa Encarnación, December 27, 1904.

[Mr. Schrottky does not refer to the numerous South American

species of *Prosopis* described by Vachal in Ann. Soc. Ent. France, 1901, pp. 79–82, but after comparing the descriptions, I do not believe any of them are identical with those described above. For the convenience of students, I give a table of the Vachalian species, using the characters employed in Mr. Schrottky's table as far as possible. I also include a lately-described Mexican species.

Scutellum nearly all yellow; first abdominal segment not ferruginous; legs not fulvous............1.
Scutellum black, with at most a yellow spot on each side............2.
1. Mesopleurae and mesosternum sparsely punctured (Bolivia) *scrobicauda,* Vach. ♀.
Mesopleurae and mesosternum densely punctured (Peru) *aspricollis,* Vach. ♀.
2. A yellow spot at each side of scutellum............3.
No such spot; scutellum all black............4.
3. Mandibles red or reddish (Goyas, Brazil)............*arsenica,* Vach. ♀.
Mandibles yellow (Peru)............*cribellata,* Vach. ♂.
4. Clypeus yellow............5.
Sides of clypeus black, the face having three yellow vittae............6.
5. All the tibiae yellow (Mexico)............*crenulata,* Ckll. ♂.
Hind tibiae black, with a yellow basal annulus (Bolivia) .*palmaris,* Vach. ♂.
6. Radial cell broad, scarcely acute; flagellum obscure reddish beneath (Bolivia)............*breviradia,* Vach. ♀.
Radial cell normal, or not broad and short............7.
7. Legs black; insect well punctate (Peru)............*atripes,* Vach. ♀.
Legs with some yellow markings or spots; insect less punctate............8.
8. Larger; hind tibiae with a yellow basal annulus (Bolivia) *stilbaspis,* Vach. ♀.
Smaller; hind tibiae with only yellow basal spots (Bolivia) *fissa,* Vach., ♂, ♀.

—*T. D. A. Cockerell.*]

The following species, observed at Villa Encarnación, are additional to the fauna of Paraguay:

Family *Chrysididæ:*
Holopyga lazulina Dahlbom.
Family *Mutillidæ:*
Rhoptromutilla hepatica (Gerstaecker).
Mutilla scoparia (Gerstaecker).
Family *Sphegidæ:*
Sphex opacus Dahlbom.
Family *Bembecidæ:*
Bembidula discisa Taschenberg.
Monedula signata (Linnaeus).
Family *Eumenidæ:*

Eumenes canaliculata.
Montezumia ferruginea Saussure.
Family *Vespidæ:*
Polistes carnifex Fabricius.
Polistes ferreri Saussure.
Polybia sericea (Olivier).
Family *Apidæ:*
Temnosoma metallicum Smith var. *chapadæ* Cockerell.
Augochlora graminea Fabricius.
Augochlora mulleri Cockerell.
Augochlora nana Smith.
Augochlora vesta Smith var. *cupreola,* Cockerell.[1]
Psaenythia facialis Gerstaecker.
Ceratina maculifrons Smith.
Hemisia lanipes (Fabricius).
Bombus carbonarius Handlirsch.
Bombus cayennensis Fabricius.
Trigona clavipes Fabricius.

I formerly indicated *Entechnia taurea* Say as belonging to the Paraguayan fauna; but this determination was wrong and the species was *Entechnia fulvifrons* Smith. The same error has been made by A. Ducke who records *E. taurea* from Pará, and also by E. L. Holmberg who recorded it from Argentina; in both cases the insect in question was *E. fulvifrons.*

[[1] Since this was described I have examined Smith's type of *A. vesta,* and find that *cupreola* is not a variety of it, but a distinct species—T. D. A. C.]

DESCRIPTION OF A NEW SQUIRREL OF THE SCIURUS PREVOSTII GROUP FROM PULO TEMAJU, WEST COAST OF BORNEO

By MARCUS WARD LYON, Jr.

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In the summer of 1905 Doctor W. L. Abbott collected on Pulo Temaju two specimens of a squirrel related to *Sciurus prevostii*, but which differ conspicuously from the known members of the *prevostii* group. Pulo Temaju[1] is a small island lying off the west coast of Borneo, about half a degree north of the equator. It is described by Doctor Abbott as "about two and one-half miles long; about four miles from the mainland of Borneo; it is hilly and most of the surface is now planted with cocoanuts." The water between it and Borneo is twelve to fourteen fathoms in depth. At Doctor Abbott's suggestion this squirrel has been named

SCIURUS PROSERPINAE new species

Type.—Skin and skull of adult female, No. 142285, United States National Museum, collected on Pulo Temaju, about four miles off the west coast of Borneo, June 9, 1905, by Doctor W. L. Abbott. Original number, 4180.

Diagnostic characters.—Related to *Sciurus borneoensis* Schlegel; but the usual white side stripes, nearly suppressed, darkened to slate-gray, and the underparts generally the seal-brown of Ridgway.

Color.—Upperparts of head and body, upper surfaces of feet, outer surfaces of legs and basal and terminal sixths of tail, black; underparts of body and inner surfaces of legs, a fine grizzle of a dark reddish-brown and black, producing a general effect of seal-brown. Base of whiskers, a grizzle of black and white, the latter color predominating; cheek spot present, but very inconspicuous; the shoulders faintly grizzled with light buffy; lateral stripe, short, 60–70 mm. in length, about 10 mm. wide; the hairs with black bases and dull white ends, but many are black throughout. The general effect of the stripe at arm's length is slate-gray. The lateral stripe is separated from the seal-brown underparts by a narrow (2–3 mm.), black

[1] Also written Temadjoe and Temadju.

stripe. Basal and terminal sixths of tail, black; the middle four-sixths, a coarse grizzle of black and white.

Skull.—Aside from the somewhat smaller audital bullæ, skulls of *Sciurus proserpinæ* do not differ from skulls of *S. borneoensis.*

Measurements.—Type, No. 142285, United States National Museum, adult female, and paratype, No. 142284, adult male, respectively: Head and body, 233, 235 mm.; tail vertebræ, 230, 235; hind foot, with claws, 59, 61; greatest length of skull, 53.7, 53.9; basal length, 45.5, 45.8; zygomatic breadth, 34.8, 34; interorbital constriction, 22.7, ——; breadth of brain-case above roots of zygomata, 24.6, 25; mandible, back of condyle to front of symphysis, 34.4, 34.9.

Specimens examined.—Two.

Remarks.—*Sciurus proserpinæ* differs from the other members of the *prevostii* group in its general melanistic trend. The lateral stripe is not only much reduced, but the underparts are nearly black instead of a reddish-brown or chestnut. The grizzled tail and slight grizzling about the shoulders show it to be related to the nearby *S. borneoensis,* rather than to the other dark members of the group, *S. piceus* and *S. pluto.*

THE SQUIRRELS OF THE SCIURUS VITTATUS GROUP IN SUMATRA

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That more than one form of this variable group of squirrels should be found on Sumatra is not surprising when the large size and physical characteristics of that island are borne in mind. Sumatra is nearly one thousand miles in length, extending from northwest to southeast. The western portion is mountainous, averaging about 2000 feet in elevation, with here and there volcanic peaks 10,000 or 11,000 feet high; the eastern side consists of low and swampy land. Dr. W. L. Abbott during the last six years has collected squirrels of the *Sciurus vittatus* group at the following points along the coast: *East side;* Aru Bay, November to December, 1905; Salat Rupat, March, 1906; Kateman river, August, 1903; Indragiri river, September, 1901; *west side;* Loh Sidoh Bay, November, 1901; Tapanuli Bay, February and March, 1902; Tarussan Bay, December, 1904. See map, page 283. The only specimens of this group I have seen from the highlands of Sumatra are two from vicinity of Padang, kindly loaned by Mr. Witmer Stone, of the Academy of Natural Sciences of Philadelphia, to whom my thanks are due.

The type locality of *Sciurus vittatus* Raffles[1] is Bencoolen, on the southwest coast of Sumatra. Unfortunately, from here I have seen no examples. Mr. Bonhote's[2] statement that "the *types* of *S. vittatus,* which are in the British Museum, are absolutely indistinguishable from specimens taken in the Peninsula" and an examination of material in the National Museum show that *Sciurus vittatus* on Sumatra ranges throughout the low marshy country of the eastern side and extends either across the mountains or around the coast to Bencoolen, which seems rather unusual with so variable a group of squirrels; or else that the types of *Sciurus vittatus* were incorrectly labeled as coming from Bencoolen, a not improbable occurrence with specimens collected nearly a century ago. The examples nearest in locality to Bencoolen which I have seen are those from

[1] *Trans. Linnean Soc. London,* xiii, 1821–1822, p. 259.

[2] *Proc. Zool. Soc. London,* 1906, Vol. i, p. 6, June 7, 1906.

Tarussan Bay which are quite different from specimens collected along the low east coast of the island. The latter cannot be distinguished from *Sciurus peninsularis* Miller.[1] Until a good series of specimens is collected at Bencoolen the status of *Sciurus vittatus* Raffles and of *Sciurus peninsularis* Miller, must remain unsatisfactory. In this paper I use these two names as synonymous.

The differences in color of the different forms do not appear to be dependent upon season, but it is much to be regretted that material collected at all seasons is not available from each type locality. The east coast series, collected from March to September, is quite uniform and the relatively slight variations are individual and not seasonal. Two of the most differently colored forms (from Tarussan Bay and Tapanuli Bay) differ only a month as to season in which collected and are nearest geographically.

It is probable that the four forms here recognized are true subspecies of *Sciurus vittatus* and that if specimens were available from intermediate localities complete intergradation of one form to another would be found. As it is, the forms described below are quite distinct and the individual variation in any series is hardly great enough to connect one variety with another. Once the characters of the different forms are known, each of the thirty-four skins of squirrels of this group collected by Dr. Abbott in Sumatra can, without reference to the labels, be referred to one of the four different subspecies here described.

Apparently there are no characters in the skull by which the different subspecies may be distinguished from each other, except the slightly smaller size in the northern race.

Key to the Sumatran Squirrels of the Sciurus Vittatus Group

A. Pelage with scattered white hairs on underparts.
Sciurus vittatus albescens.

A'. Pelage without scattered white hairs on underparts.

- *C*. Underparts lighter, deep ochraceous-buff...*Sciurus vittatus tarussanus.*
- *C'*. Underparts darker, deep orange-rufous to ferruginous.
  - *D*. Upper surfaces of feet dull tawny or ochraceous, and black lateral stripe more distinct and clear........*Sciurus vittatus vittatus.*
  - *D'*. Upper surfaces of feet inclining to grayish, not tawny or ochraceous; black lateral stripe less clear and distinct.
Sciurus vittatus tapanulius.

SCIURUS VITTATUS VITTATUS Raffles

1822. *Sciurus vittatus* RAFFLES, Trans. Linnean Soc. London, XIII, p. 259.

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[1] Smithsonian Miscell. Coll., XLV, No. 1420, November 6, 1903, p. 10.

1903. *Sciurus peninsularis* MILLER, Smithsonian Miscell. Coll., XLV, p. 10, November 6, 1903.[1]

Co-types.—In British Museum, not seen.

Distribution.—Bencoolen (type locality) and the low swampy lands of southeastern Sumatra. See map, page 283.

Color.—Based on specimens from the low lands of eastern Sumatra, collected by Dr. Abbott. Upperparts, a fine grizzle of black and tawny-olive; tail similar, but grizzle coarser, sometimes appearing annulated and often somewhat rufescent toward the tip. Cheeks practically concolor with upperparts. Upper surfaces of feet, a fine grizzle of black and ochraceous or tawny-ochraceous. Underparts, orange-rufous or ochraceous-rufous, rarely deepening to ferrugineous in some specimens. Light side stripe, about 5 mm. wide, dirty buff or cream-buff; black stripe, averaging 10–15 mm. wide, almost clear black.

Measurements.—Skin of No. 113156, United States National Museum, adult male, Indragiri river, Sumatra: Head and body, 220 mm.; tail vertebræ, 185; hind foot with and without claws, 48 and 44. Skull of No. 113156: Basal length, 44 mm.; zygomatic breadth, 31; interorbital constriction, 18.4; breadth of brain-case above roots of zygomata, 23.3.

Specimens examined.—Eleven skins and skulls; Salat Rupat, 3; Kateman river, 3; Indragiri river, 5.

SCIURUS VITTATUS TARUSSANUS new subspecies

Type.—Adult female, skin and skull, No. 141038, United States National Museum, collected at Tarussan Bay, west coast of Sumatra, December 28, 1904, by Dr. W. L. Abbott. Original number, 3857.

Distribution.—Vicinity of Tarussan Bay, Sumatra. See map, page 283.

Diagnostic characters.—Similar to typical *Sciurus vittatus*, but black side stripe rather narrower and less clear and underparts ochraceous or orange-ochraceous instead of ferrugineous or orange-rufous.

Color.—Upperparts and tail, a fine grizzle, coarser on the tail

[1] This species was described by Mr. Miller under the assumption that the Tapanuli Bay squirrels represented typical *vittatus*. Material at that time was insufficient to show that several forms of the *vittatus* group occurred on Sumatra. If, as Mr. Bonhote states, *S. peninsularis* is identical with the types of *S. vittatus*, *S. peninsularis* is a synonym of *S. vittatus* and the Tapanuli Bay specimens represent a new form, not named until now.

which is somewhat annulated and often slightly rufous at the tip, of black and tawny-olive. Cheeks generally concolor with upperparts, but sometimes inclining to yellowish. Upper surfaces of feet, a fine grizzle of ochraceous or tawny-ochraceous and black. Underparts and inner surfaces of legs varying between ochraceous and orange-ochraceous. Light lateral stripe, about 5 mm. wide, varying between buff and cream-buff in color; black stripe, 3–5 mm. wide posteriorly, 8–10 mm. anteriorly, finely and slightly grizzled with tawny-olive.

Measurements.—Skin of type: Head and body, 215 mm.; tail vertebræ, 185; hind foot, with and without claws, 48 and 44. Skull of type: Basal length, 43 mm.; zygomatic breadth, 31.4; interorbital constriction, 18.4; breadth of brain-case above roots of zygomata, 23.3; maxillary toothrow, 9.7.

Specimens examined.—Six skins, with skulls, from Tarussan Bay, and two skins, with skulls, from Padang Bovenland, at Batu Sangkar, Tanah Datar, 1,500–3,000 feet.

Remarks.—Although *Sciurus vittatus tarussanus* is nearer geographically to typical *vittatus* (type locality, Bencoolen), yet its lighter underparts and duller side stripes separate it sharply from *Sciurus peninsularis* Miller, which Mr. Bonhote states is identical with Raffles' types of *S. vittatus.*

SCIURUS VITTATUS TAPANULIUS new subspecies

Type.—Adult male, skin and skull, No. 114519, U. S. National Museum, collected at Tapanuli Bay, west coast of Sumatra, February 21, 1902, by Dr. W. L. Abbott. Original number, 1560.

Distribution.—Vicinity of Tapanuli Bay, Sumatra. See map, page 283.

Diagnostic characters.—Similar to typical *Sciurus vittatus,* but upper surfaces of feet grayish tawny-olive instead of ochraceous; cheeks more inclined to ochraceous-buff, and black lateral stripe narrower and less clear.

Color.—Upperparts and tail, as in typical form, a fine grizzle, (coarser on the tail, which is somewhat annulated), of black and tawny-olive. Upper surfaces of feet, a grizzle of tawny-olive, and black; underparts and inner sides of legs varying from orange-rufous to ferrugineous. Cheeks, dull ochraceous-buff. Light lateral stripe, about 5 mm. wide, cream-buff; dark stripe, about 5 mm. wide posteriorly, 10 mm. anteriorly, black, but finely grizzled with the color of the underparts.

Measurements.—Skin of type: Head and body, 208 mm.; tail vertebræ, 185; hind foot, with and without claws, 45 and 41. Skull of type: Basal length, 43.3 mm.; zygomatic width, 29.5; interorbital constriction, 18; brain-case above roots of zygomata, 23; maxillary toothrow, 9.

Specimens examined.—Nine skins, with skulls, from Tapanuli Bay.

Remarks.—Although close to the typical form, *Sciurus vittatus tapanulius* is easily distinguished by having the upper surfaces of the feet generally concolor with the upper parts of body, by the yellowish cheeks, and by the less clear black side stripe. It somewhat resembles *S. ictericus* Miller[1] of the Batu Islands, but the cheeks are not nearly so yellow and the light lateral stripe is much clearer.

SCIURUS VITTATUS ALBESCENS (Bonhote)

1901. *Sciurus notatus albescens* BONHOTE, Ann. Mag. Nat. Hist., ser. 7, VII, May, 1901, p. 446.

Type.—British Museum, 85, 8, 1, 235. I have not seen this, but regard the Loh Sidoh Bay specimens as topotypes.

Distribution.—Northern Sumatra.

Diagnostic characters.—Differs from typical *Sciurus vittatus* in having paler underparts which, as well as the black lateral stripe, are lined with a few or many white hairs. Somewhat like *Sciurus pannovianus* Miller[2] but black stripe much narrower.

Color.—Upperparts and tail as in the typical form, a fine grizzle, coarser on the tail, of black and tawny-olive. Upper surfaces of feet a grizzle of ochraceous-buff and black. Cheeks, dull ochraceous-buff. Underparts and inner surfaces of legs, a color between orange-rufous and pinkish-buff, sprinkled with few or many white hairs. Light lateral stripe, 3–5 mm. wide, cream-buff; black stripe, 5 mm. wide posteriorly, 10 mm. anteriorly, sprinkled with few or many white hairs and some of the rufescent hairs of the underparts; the black hairs are dark to their bases where they are slate color.

Measurements.—No. 143400, United States National Museum, from Aru Bay: Head and body, 205 mm.; tail vertebræ, 200; hind foot, with and without claws, 44, 40. Skull: Basal length, 42.2 mm.; zygomatic width, 28.7; interorbital constriction, 17.5; brain-case above roots of zygomata, 23; maxillary toothrow, 9.

Specimens examined.—Two skins and skulls from Aru Bay, and eight from Loh Sidoh Bay.

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[1] Smithsonian Miscell. Coll., XLV, p. 12, November 6, 1903.

[2] Smithsonian Miscell. Coll., XLV, p. 11, November 6, 1903.

Remarks.—Dr. Abbott's specimens, while differing in some respects from Bonhote's original description of *albescens,* are from too near the type locality to be considered anything else, at least until an actual comparison with the type has been made. The Aru Bay skins have less white on the underparts and lateral line than the majority of those from Loh Sidoh Bay, but two of the latter are exact matches for the Aru Bay specimens. The type of *Sciurus albescens* is said to have white hairs in the pelage above, but there are practically none in any of Dr. Abbott's specimens.

Fig. 29.—Sketch map of Sumatra showing distribution of squirrels of the *Sciurus vittatus* group.

A STUDY IN BUTTERFLY WING–VENATION, WITH SPECIAL REGARD TO THE RADIAL VEIN OF THE FRONT WING

BY THOMAS J. HEADLEE

After making wide studies of pupal and adult wings in nearly all orders of insects, Comstock and Needham ('98)[1] constructed an hypothetical type of wing venation, which they believed closely to represent, in number and branching of the veins, the condition that existed in the ancestors of the present winged insects. Later ('04), Comstock[2] modified this type by the addition of three typical cross veins (text fig. 30).

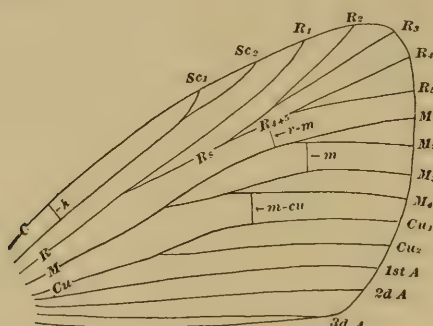


FIG. 30.—Hypothetical type of primitive insect wing.

In passing from this to the lepidopterous type, the third anal vein of the fore wing becomes two-branched, and the second anal vein of the hind wing two-rooted (text figs. 31, 32). Except in the anal area where there has been a great reduction, such Jugatæ as *Hepialus* and *Sthenopis* well represent this type (pl. LX, figs. 1–4).

However, by far the larger number of Lepidoptera belong to the Frenatæ and exhibit a much greater modification of wing veins. In passing from the generalized lepidopterous to the frenate type, the humeral cross-vein disappears, subcosta of both wings is reduced to an unbranched vein, media of both wings reduced to three branches,

[1] J. H. Comstock and J. G. Needham, The Wings of Insects, *Amer. Nat.*, XXXII and XXXIII, 1898 and 1899.

[2] J. H. Comstock, How to Know the Butterflies, p. 9, 1904.

and in the hind wing costa has become a mere vestige in the humeral edge of the wing, a frenulum is developed on the humeral angle, radius reduced to two branches, and radius-one coalesced with subcosta from distal end almost to base (text figs. 33, 34). This type is illustrated by *Castnia cochrus* (pl. LX, figs. 5, 6).

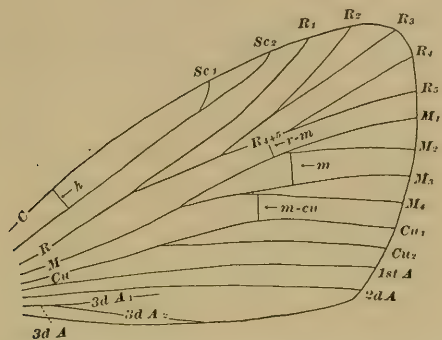


FIG. 31.—Hypothetical type of primitive lepidopterous fore wing.

With the exception of the two-rooted condition of the second anal vein of the hind wing, all these modifications have been recognized and discussed by previous workers, so I shall pass them without further discussion. Inasmuch as this two-rooted condition appears in some of the most generalized Lepidoptera and in widely

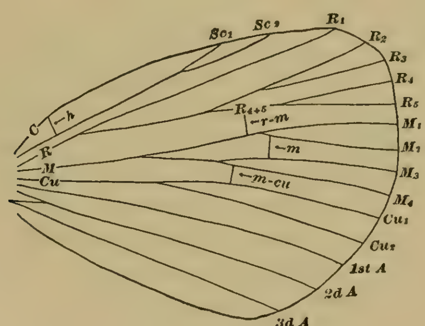


FIG. 32.—Hypothetical type of primitive lepidopterous hind wing.

separated forms, such as *Micropteryx, Prionoxystus robiniæ, Phassus triangularis,* and *Euschemon rafflesiæ,* it should be figured in the lepidopterous hypothetical type (text figs. 32, 34, pl. LXI, figs. 7 to 10).

Extended study of pupal and adult wings has convinced me that,

while the frenate type of hind wings will serve, unmodified, as typical of both heterocerous and rhopalocerous hind wings, the frenate type of fore wing will by no means serve equally well as typical of these fore wings. While the latter will serve as a type of the

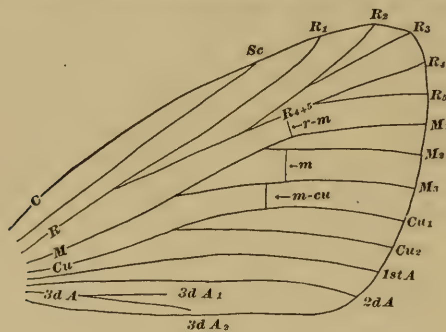


FIG. 33.—Hypothetical type of primitive frenate fore wing.

frenate heterocerous fore wing, the rhopalocerous type shows a different condition of radius (text fig. 35).

Inasmuch as the wide occurrence and the significance of this modification of the rhopalocerous radius has been heretofore overlooked, I will discuss it in detail.

In the hypothetical type of insect wing, radius is primarily two-branched, forming radius-one and the radial sector. The latter soon

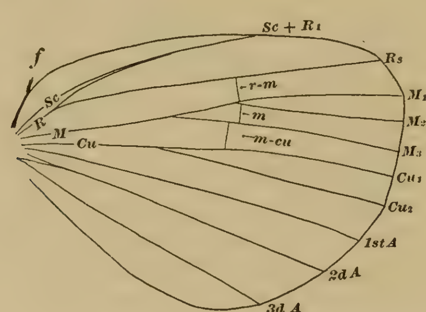


FIG. 34.—Hypothetical type of primitive frenate hind wing.

divides, giving rise to radius-two-plus-three and radius-four-plus-five. Each of these again divides into two branches, radius-two-plus-three into radius-two and radius-three; radius-four-plus-five into radius-four and radius-five. Thus the vein ultimately becomes five branched.

My own studies have convinced me that this primitive type of radius prevails among the most generalized lepidoptera such as *Hepialus, Sthenopis,* and *Castnia cochrus.* Spuler also evidently considered this type the most primitive in the Lepidoptera, for he figured this exact condition in his "Schema des Vorderflügelgeäders der Schmetterlinge"[1] (pl. LX, figs. 1–5 and 11).

This, then, being the prevailing condition of radius not only in the most generalized lepidopterous wings but also in generalized insect

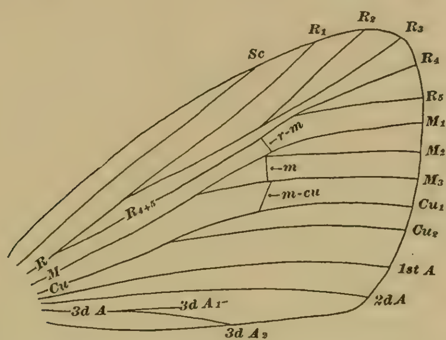


FIG. 35.—Hypothetical type of primitive rhopalocerous fore wing.

wings generally, as was shown by Comstock and Needham, may safely be laid down as the primitive lepidopterous radius from which the present types have been developed. Usually the modifications take the form of a coalescence between the radial branches, or of a more or less complete atrophy of individual branches. In fact, these are the means by which the heterocerous radius has been modified. The rhopalocerous radius, on the other hand, shows not only the effects of such modifications but of a splitting back of R_{4+5} until it finally comes to arise near the base of the main stem of radius (text fig. 35). The traces of the last appear in the adult wing of *Anosia plexippus* in the form of two spurs and a connecting line. One of the spurs is very short and projects from the base of radius into the discal cell and toward the outer edge of the wing, the other projects from the base of M_1 into the discal cell and toward the base of the wing, while the line connects the two spurs (plate fig. 12). Although these traces are of themselves suggestive, they are not convincing proof of such a modification of radius. The tracheation of the pupal wing, however, clearly explains and supplements the evidence furnished by these remnants. Trachea R_{4+5} is found to follow

[1] A. Spuler, Zur Phylogenie und Ontogenie des Flügelgeäders der Schmetterlinge, *Zeitschr. wiss. Zool.,* LIII, 4, 1892, pp. 597–646.

exactly the line which, in the adult wing, will be occupied by the structures just described (pl. LIX, 1). These spurs surely represent a once well-developed vein which in the course of phylogeny has almost disappeared. As might be expected from the fact that they are vestiges of a disappearing structure, these traces vary in degree of preservation from a strong well-marked condition to total absence. It is comparatively rare to find the line and both spurs well preserved in the same wing; usually one or more of these vestiges has been lost. The spur at the outer end of the cell is not always on M_1 but in many cases rests on radius, as in *Semnopsyche diana* (plate fig. 13). It is not always an easy matter to see these traces, even in cleared and mounted wings where they are present, but in photographs, where all structures are magnified, their presence can readily be detected. There are, however, numerous examples in which such vestiges are visible in the unbleached and unmounted wing, as in certain species of the larger *Papilios* (pl. LIX, 2). The variation in the position of the spur lying nearer the outer end of the discal cell is significant of different courses of phylogenetic development. These I shall attempt to trace in the following paragraphs.

In many wings, such as those of *Anosia plexippus* and *Apostraphia charithonia,* this spur is located on the base of M_1; in others, of which *Semnopsyche diana* is typical, it occurs on radius just before the end of the discal cell; and in still other cases, such as *Diæthria clymena,* it lies on radius proximad of the origin of R_1 (pls. LX, LXI, figs. 12–15). All stages from the condition in *Anosia* to that in *Diæthria* have been found.

The position of the spur on the base of M_1 is due to a complete coalescence of R_{4+5} with the radio-medial cross-vein and, following that, a short coalescence with M_1. While this process has resulted in the real obliteration of the radio-medial cross-vein, it has produced an apparent cross-vein between M_1 and R; for, when the basal part of R_{4+5} has atophied, nothing but a more or less well-marked stump is left on M_1 to explain that this apparent cross-vein is none other than the stem R_{4+5} passing over to coalesce for a distance with R before reaching the outer edge of the wing. This apparent cross-vein differs in direction from the real cross-vein. The former extends obliquely from M_1 toward the apex of the wing, while the latter extends obliquely from R toward the outer hind corner (plate figs. 14 and 15). The first type is almost characteristic of the Neotropidæ, Danaidæ, Heliconidæ, and Libytheidæ, and the second occurs very generally in the Nymphalidæ, Satyridæ, Morphidæ, Brassolidæ, and Acræidæ.

The variation in the position of this spur nearer the outer end of the discal cell is due, when it lies on radius, to the distance to which the coalescence between R_{4+5} and R has proceeded toward the base of the wing. It may have continued to a point just proximad of the discal cell apex, as in *Semnopsyche diana,* or it may have continued until, as shown in *Diæthria clymena,* R_{4+5} both arises from and again fuses with radius before R_1 arises (pl. LXI, figs. 13 to 15).

In all these cases, however, that part of R_{4+5} within the limits of the discal cell and not coalesced is always more or less completely atrophied. In order to understand how this has come about, it is necessary to sketch some of what I believe to be the phylogenetic history of this vein.

Primitively R_{4+5} was unconnected with radius except at point of origin. Later a connection between it and R was established at or near the apex of the present discal cell. This connection, which took in some cases the form of a short cross-vein and in others the form of a coalescence, must have preceded any weakening of the former vein because, so long as R_{4+5} was the sole air passage to and brace-rod of the veins R_4 and R_5, natural selection would tend to preserve it, but when this connection became established that part of R_{4+5} between the origin and the connection became not only useless but, through its weight and the energy consumed in forming it, a positive handicap to the species possessing it. Tendencies toward atrophy of this part were siezed upon by natural selection and in the forms that we know, it has everywhere disappeared as a distinct vein, leaving only more or less well-preserved vestiges.

From the fact that this modification of radius, the variation and loss of which we have just seen, seems to have come about through a splitting back of the vein in question, I shall refer to it as the split-back condition of R_{4+5}. It is also to be noted that the places at which the other branches of radius originate have moved, if at all, toward the outer edge of the wing.

Spuler found this condition of radius in the pupal wings of *Vanessa io* and *Papilio machaon* and gave good figures of pupal and adult wings showing it. He, however, considered the state of radius in *Dasychira pudibunda,* in which trachea R_{4+5} arises from trachea R proximad of the origin of R_1, as comparable to although less developed than, that in *Vanessa* and *Papilio* (pl. LXI, fig. 16). This is not the case, for the actual point of origin of R_{4+5} is not greatly changed, as may be seen by a comparison of it with the forking of media. This deceptive appearance is due to the coalescence of R_1

with R_5 and R_{2+3}, as is also a similar appearance in the adult wing of *Tascina orientalis*. This discovery of a split-back condition of R_{4+5} in *Papilio* and *Vanessa* has passed unnoticed by later workers.

Although these vestiges in three forms of Rhopalocera (*Anosia, Papilio,* and *Vanessa*) should certainly be interpreted as evidence of a split-back condition of the vein R_{4+5}, it was necessary that pupal conditions in other groups should be investigated before the same interpretation could be applied to similar structures in them. Accordingly I have removed, mounted, and photographed pupal wings of *Epargyreus tityrus, Anosia plexippus, Papilio polyxenes, Euvanessa antiopa, Basilarchia archippus, Vanessa cardui, Pieris rapæ,* and *Feniseca tarquinius* (pls. LXI, LXII, figs. 17, 21, 25, 27, 29, and LIX, fig. 1). In the first six, radius showed very clearly this split-back condition but, although all stages from the mature caterpillar to the adult butterfly were examined, the last two showed a four-branched radial trachea in which there was no evidence of any such modification. The choice of *Pieris rapæ* as a representative of the Pieridæ was unfortunate, for all traces of this splitting back of R_{4+5} have disappeared from both pupal and adult wings, while the adult wings of *Eurymus philodice* and *Anthocharis sara* show these traces very well preserved and it is therefore very probable that, had their pupæ been examined, the split-back condition of R_{4+5} would have been found (pl. LXII, figs. 31 and 32). On the other hand, *Feniseca* was probably as good a type as the North American Lycænidæ could furnish, for the vein reduction has proceeded to such an extent in this family that very few of its members retain any traces of this modification. The forms in my possession which do retain such traces come from South America and southern Asia (pl. LXIII, fig. 33).

The wide occurrence of these vestiges, which are clearly remnants of a split-back condition of the vein R_{4+5}, renders entirely justifiable the interpretation of similar structures in related forms as homologous and signifying the same condition. These vestiges occur in all families and in the following examples they are especially well marked: *Epargyreus tityrus* of the Hesperidæ; *Papilio polyxenes* of the Papilionidæ; *Parnassius smitheus* of the Parnassidæ; *Hypatus bachmani* of the Libytheidæ; *Anosia plexippus* of the Danaidæ; *Leucothyris quinatina* of the Neotropidæ; *Apostraphia charithonia* of the Heliconidæ; *Semnopsyche diana* and *Euphydryas phaeton* of the Nymphalidæ; *Catoblepia* sp. of the Brassolidæ; *Morpho* sp. of the Morphidæ; *Erebia tyndarus* of the Satyridæ; *Anthocharis sara* of the Pieridæ; *Arhopala hercules* of the Lycænidæ (pls. LX–LXIII, figs. 18, 22, 34, 35, 12, 38, 14, 13, 37, 36, 39, 40, 32 and 33).

I have cited only a few of the examples available and, while they show how widely this modification is scattered through the groups, they show nothing of its prevalence among the members of the individual families, and consequently nothing very conclusive as to its history and significance. In order to get light on this point I carefully examined the mounted and photographed wings of 171 species, representing 158 genera and 16 families of Rhopalocera. These wings were taken from specimens representing all the life zones of the world, a majority being secured from North, Central, and South America. This latter fact does not impair the universal nature of the evidence for South America alone, according to Staudinger and Schatz ('85),[1] possesses 272 genera represented by 4,500 species, or about one-half of all the butterflies then known. All my specimens of the following families show traces of a split-back condition of R_{4+5}: four genera of the Papilionidæ; one genus of the Parnassidæ; one genus of the Danaidæ; fourteen genera of the Neotropidæ; three genera of the Heliconidæ; one genus of the Libytheidæ; two genera of the Brassolidæ; one genus of the Morphidæ. In the following families the relative number which show distinct traces of this modification is indicated by per cent: 89 per cent. for forty-one genera of the Nymphalidæ; 80 per cent. of fifteen genera of the Satyridæ; 76 per cent. of eight genera of the Hesperidæ; 70 per cent. of twenty genera of the Pieridæ; 50 per cent. of one genus, represented by two species, of the Acræidæ; 14 per cent. of seven genera of the Erycinidæ; 7 per cent. of twenty-seven genera of the Lycænidæ. Thus in eight families all specimens and in five 50 per cent. or more show traces of this modification of radius, while in only two does the per cent. fall below fifty. These facts serve to show that this modification of radius is exceedingly prevalent and, to the student of rhopalocerous wings, also that, in general, it prevails most completely in those wings which have experienced the least reduction of other veins and are, in fact, the most generalized.

The wide distribution of this modification of radius and the fact that it is best preserved in generalized wings, can best be accounted for by the supposition that radius of the progenitors of the present butterflies was characterized by a split-back condition of R_{4+5}. This character has arisen, reached its maximum development, and is now reduced to mere vestiges, even these having almost disappeared in some families.

[1] O. Staudinger and E. Schatz, Exotische Schmetterlinge, II Theil, 1885, p. 28.

Having seen the prevalence and primitive nature of this character in the Rhopalocera, the question arises as to what extent radius is thus modified in the Heterocera. To answer this I removed, photographed, and studied the pupal wings of the following moths, without, however, finding any trace of a split-back condition of R_{4+5}: *Carpocapsa pomonella* of the Tortricina, *Datana* sp. of the Notodontidæ, an undetermined species of the Geometrina, *Plusia brassicæ* of the Noctuidæ, *Alypia octomaculata* of the Agaristidæ, *Pyrrharctia isabella* of the Arctiidæ, *Phlegethontius celeus* and *Ampelophaga myron* of the Sphingidæ, *Samia cecropia, Telea polyphemus,* and *Callosamia promethea,* of the Saturniina, *Clisiocampa americana* of the Lasiocampidæ. Spuler has figured the pupal wings of *Mamestra brassicæ, Harpya vinula,* and *Smerinthus ocellata,* and none show any traces of this modification. Finding that tracheation showed no evidence of a split-back condition of R_{4+5}, I turned to the adult wings and carefully examined for such traces as were so abundant among the butterflies, 287 cleared and mounted wings, representing 216 genera and 35 families drawn principally from North America, but including such generalized forms as *Sthenopis* and *Hepialus,* and found no trustworthy evidence of any such modification. It is difficult to believe that were such vestiges at all prevalent, they would have been overlooked.

The great prevalence in Rhopalocera and the total absence in Heterocera of this split-back condition of R_{4+5} affords a striking and genetic difference between butterflies and moths. It adds a new proof to that already existing for the accepted belief that the butterfly groups are more closely related to one another than to any other living Lepidoptera.

While butterfly wings conclusively show that a split-back condition of R_{4+5} was certainly characteristic of the rhopalocerous progenitors, moth wings hint at no such condition of radius in the heterocerous progenitors. In fact, everything shows conclusively that radius was of the type represented in Spuler's lepidopterous hypothetical type, and Comstock and Needham's hypothetical type for insects. Here, then, is the point of divergence between the heterocerous and rhopalocerous stems. This separation clearly did not occur until after the Lepidoptera had divided into Jugatæ and Frenatæ, for the reduction of radius of the hind wing to a two-branched condition, and the possession of a frenulum by the male of *Euschemon rafflesiæ,* shows that the butterflies clearly belong to the Frenatæ.

We must now make use of the anal area. Inasmuch as the anal veins in the front wings of some Rhopalocera, such as *Anosia* (plate figs. 12 and 20), have been reduced more rapidly than those of the hind wings, while in other forms, such as *Papilio* (plate figs. 22 and 24), the anal veins of the hind wings have been reduced more rapidly than those of the front wings, the rhopalocerous progenitor must have had the same number of anal veins in each wing. Likewise, inasmuch as the frenate Heterocera exhibit a similar variation, the butterfly stem must have separated from the frenate stem while the number of anal veins in each wing was the same.

The Rhopalocera, according to this view, separated from the other Frenatæ while the number of anal veins in each wing was the same and when R_{4+5} became split-back to the base of radius.

In the preceding discussion I have tried to make the following points:

1. Radius of the rhopalocerous front wing exhibits a split-back condition of radius-four-plus-five.

2. This modification, now almost lost in the adult wings, characterized the wings of the primitive Rhopalocera.

3. Radius of the heterocerous front wing exhibits no traces of such a modification, and such a modification is therefore not characteristic of the primitive frenate Heterocera.

4. This modification of radius is a phylogenetic difference between butterflies and moths and is one of the characters on which the two groups diverge.

5. This divergence took place after the Frenatæ had separated from the Jugatæ, while the number of anal veins in the front and in the hind wings was the same, and when radius-four-plus-five became split-back to the base of radius.

In conclusion, I wish to acknowledge my indebtedness to Dr. A. D. MacGillivray whose helpful suggestions and criticisms have been invaluable, and to Prof. J. H. Comstock whose criticism and willingness to furnish material have made the execution of this work possible.

List of Abbreviations

C—Costal vein or trachea.
Sc—Subcostal vein or trachea.
Sc_1 and Sc_2—First and second branches of subcosta.
R—Radial vein or trachea.
R_1, R_2, R_3, R_4, and R_5—First, second, third, fourth, and fifth branches of radius.

M—Medial vein or trachea.
M_1, M_2, M_3, and M_4—First, second, third, and fourth branches of media.
Cu—Cubital vein or trachea.
Cu_1 and Cu_2—First and second branches of cubitus.
1st *A*—First anal vein or trachea.
2d *A*—Second anal vein or trachea.
3d *A*—Third anal vein or trachea.
3d A_1 and 3d A_2—First and second branches of third anal.
f—Frenulum.
H—Humeral vein or trachea.
h—Humeral cross-vein.
r-m—Radio-medial cross-vein or -trachea.
m—Medial cross-vein.
m-cu—Medio-cubital cross-vein or -trachea.

EXPLANATION OF PLATES

Plate LIX

Fig. 1. Photograph of pupal fore wing of *Anosia plexippus.*

2. Photograph of the under side of the unbleached wings of *Papilio* sp. In this form the proximal ends of the well-preserved veins bear white scales on the under side of the wings, which thus bring them into strong contrast with the darker scaled wing membrane. The vestiges of those parts of R_{4+5} and M which cross the discal cell are also covered with these white scales and are therebv made very conspicuous.

Plate LX

Fig. 1. Front wing of *Hepialus* sp.

2. Hind wing of *Hepialus* sp.
3. Front wing of *Sthenopis* sp.
4. Hind wing of *Sthenopis* sp.
5. Front wing of *Castnia cochrus* Fabricius.
6. Hind wing of *Castnia cochrus* Fabricius.
7. Hind wing of *Micropteryx* sp. (After Comstock.)
8. Hind wing of *Prionoxystus robiniæ* Peck. (After Comstock.)
9. Hind wing of *Phassus triangularis* H. Edwards.
10. Hind wing of *Euschemon rafflesiæ* Macl.
11. Diagram of the venation of the fore wing. (In every respect save that of naming the veins this is a copy of Spuler's figure.)
12. Front wing of *Anosia plexippus* Linnæus.

Plate LXI

Fig. 13. Front wing of *Semnopsyche diana* Cramer.

14. Front wing of *Apostraphia charithonia* Linn.
15. Front wing of *Diæthria clymena* Cramer.
16. Front pupal wing of *Dasychira pudibunda* Linn. (In every respect save that of naming the veins this is a copy of Spuler's figure.)
17. Front pupal wing of *Epargyreus tityrus* Fabricius.
18. Front wing of *Epargyreus tityrus.*
19. Hind pupal wing of *Anosia plexippus* Linn.
20. Hind wing of *Anosia plexippus* Linn.
21. Front pupal wing of *Papilio polyxenes* Fabr.
22. Front wing of *Papilio polyxenes* Fabr.

Plate LXII

Fig. 23. Hind pupal wing of *Papilio polyxenes* Fabr.

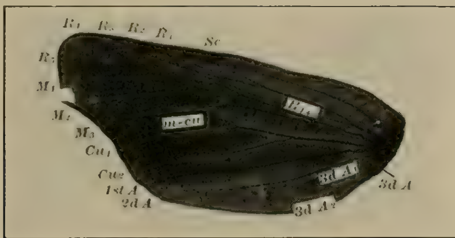
24. Hind wing of *Papilio polyxenes* Fabr.

25. Front pupal wing of *Euvanessa antiopa* Linn.
26. Front wing of *Euvanessa antiopa* Linn.
27. Front pupal wing of *Basilarchia archippus* Cram. (This wing was injured in the outer margin and anal region.)
28. Front wing of *Basilarchia archippus* Cram.
29. Front pupal wing of *Vanessa cardui* Linn.
30. Front wing of *Vanessa atalanta* Linn.
31. Front wing of *Eurymus philodice* Godart.
32. Front wing of *Anthocharis sara* Boisduval.

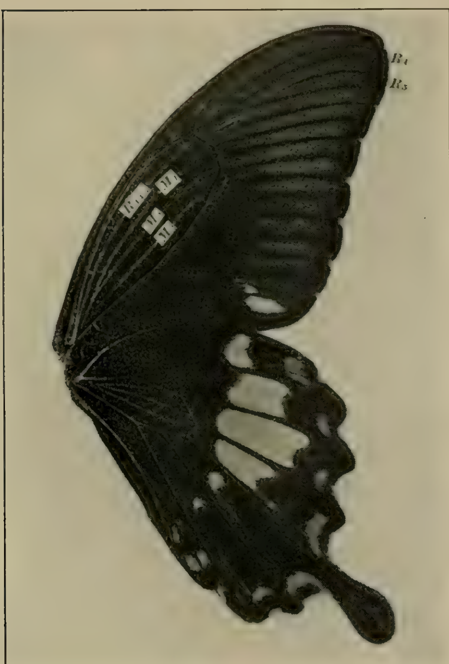
Plate LXIII

Fig. 33. Front wing of *Arhopala hercules* Hewitson.
34. Front wing of *Parnassius smitheus* Doubleday and Hewitson.
35. Front wing of *Hypatus bachmanni* Kirtland.
36. Front wing of *Catoblepia* sp.
37. Front wing of *Euphydryas phaeton* Drury.
38. Front wing of *Leucothyris quinatina* Felder.
39. Front wing of *Morpho* sp.
40. Front wing of *Erebia tyndarus* Esper.

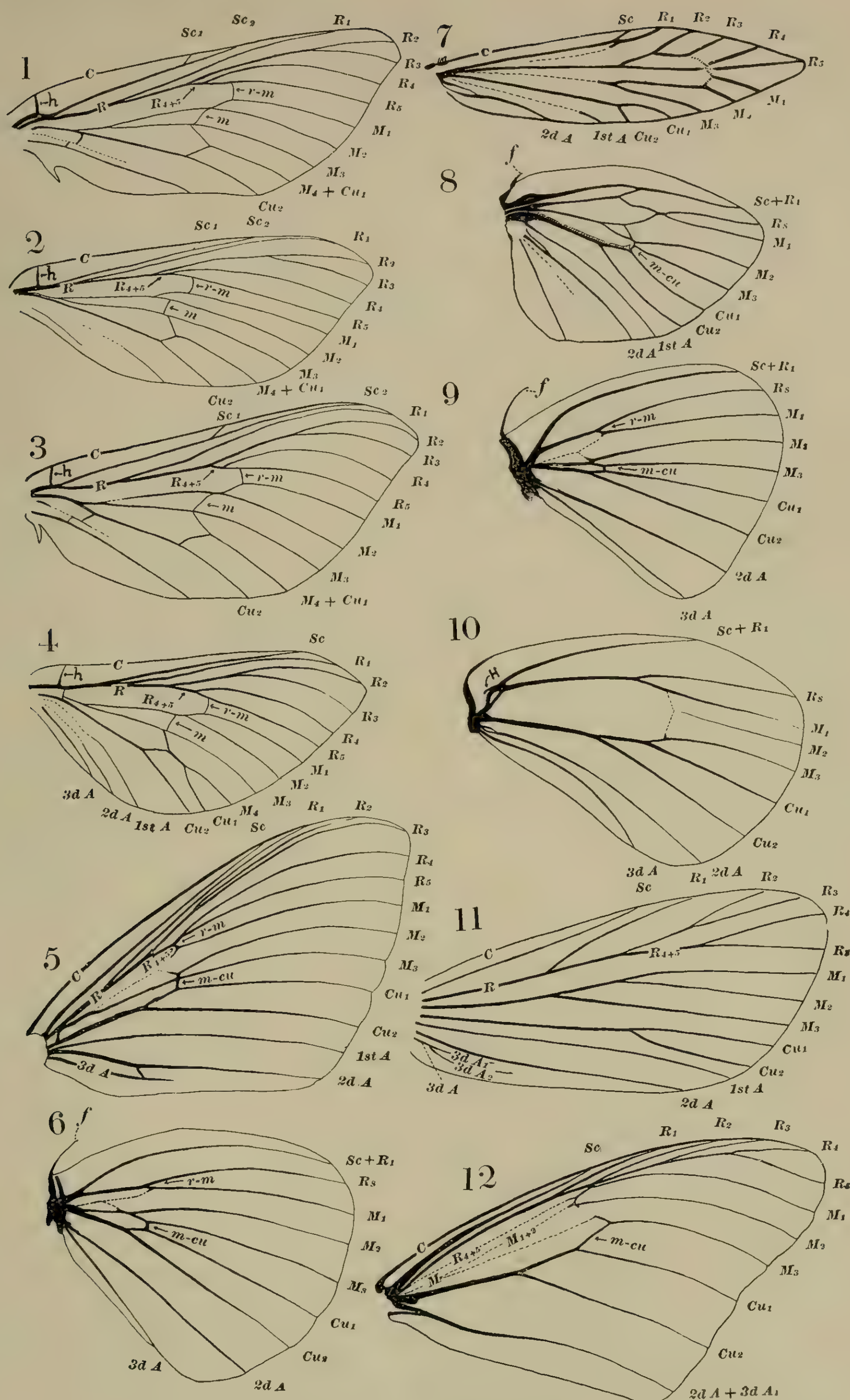
Note:—The wings figured in these plates are reproductions of the venation shown in the photographs. The image was printed on blue-print paper, the veins and outline were carefully inked in, and the blue removed by soaking in a saturated solution of potassium oxalate. Some of the pupal wings were torn in removing from the body and these were inked just as printed.



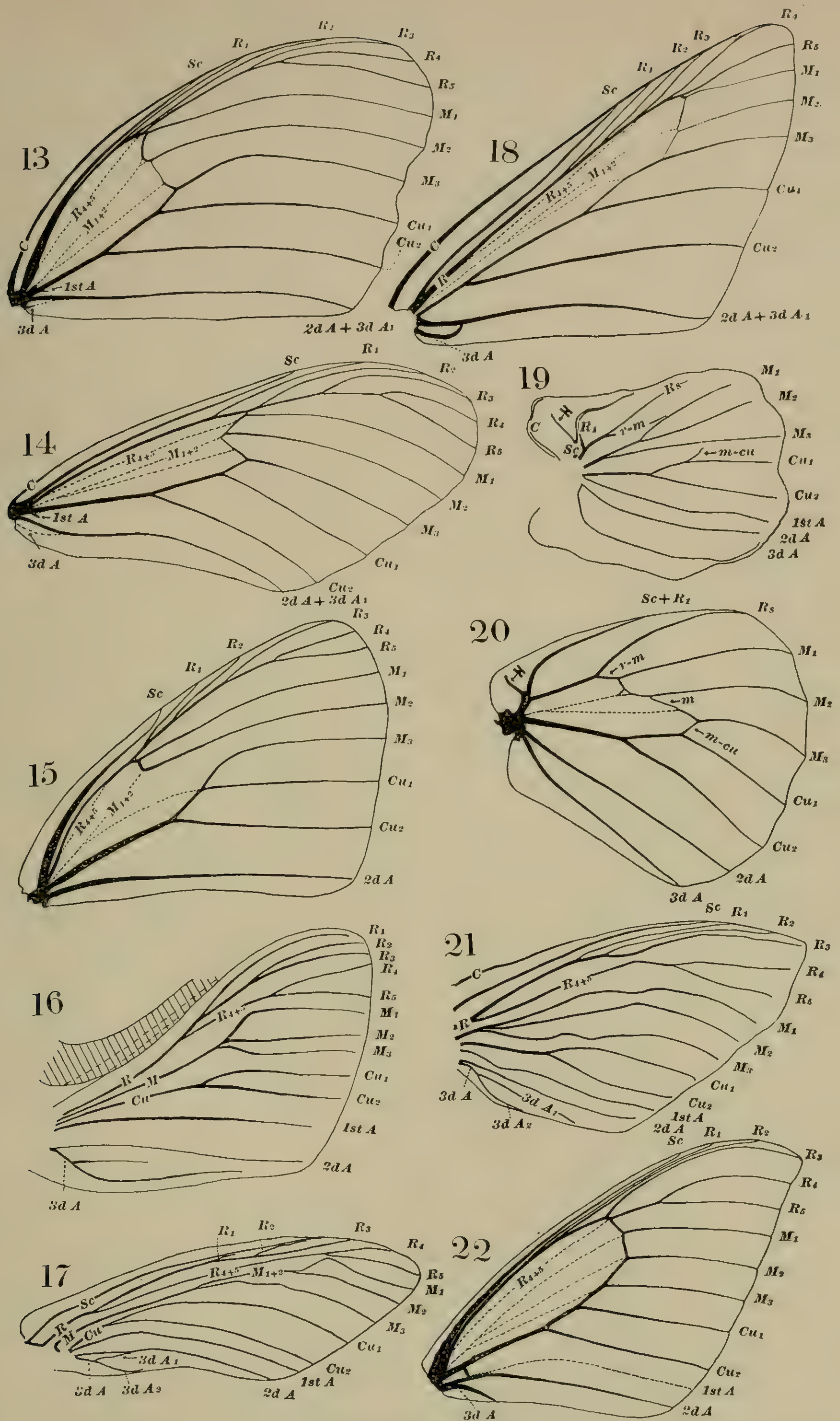
1. PUPAL FORE WING OF ANOSIA PLEXIPPUS.



UNDER SIDE OF UNBLEACHED WINGS OF PAPILIO SP.



BUTTERFLY WING-VENATION.



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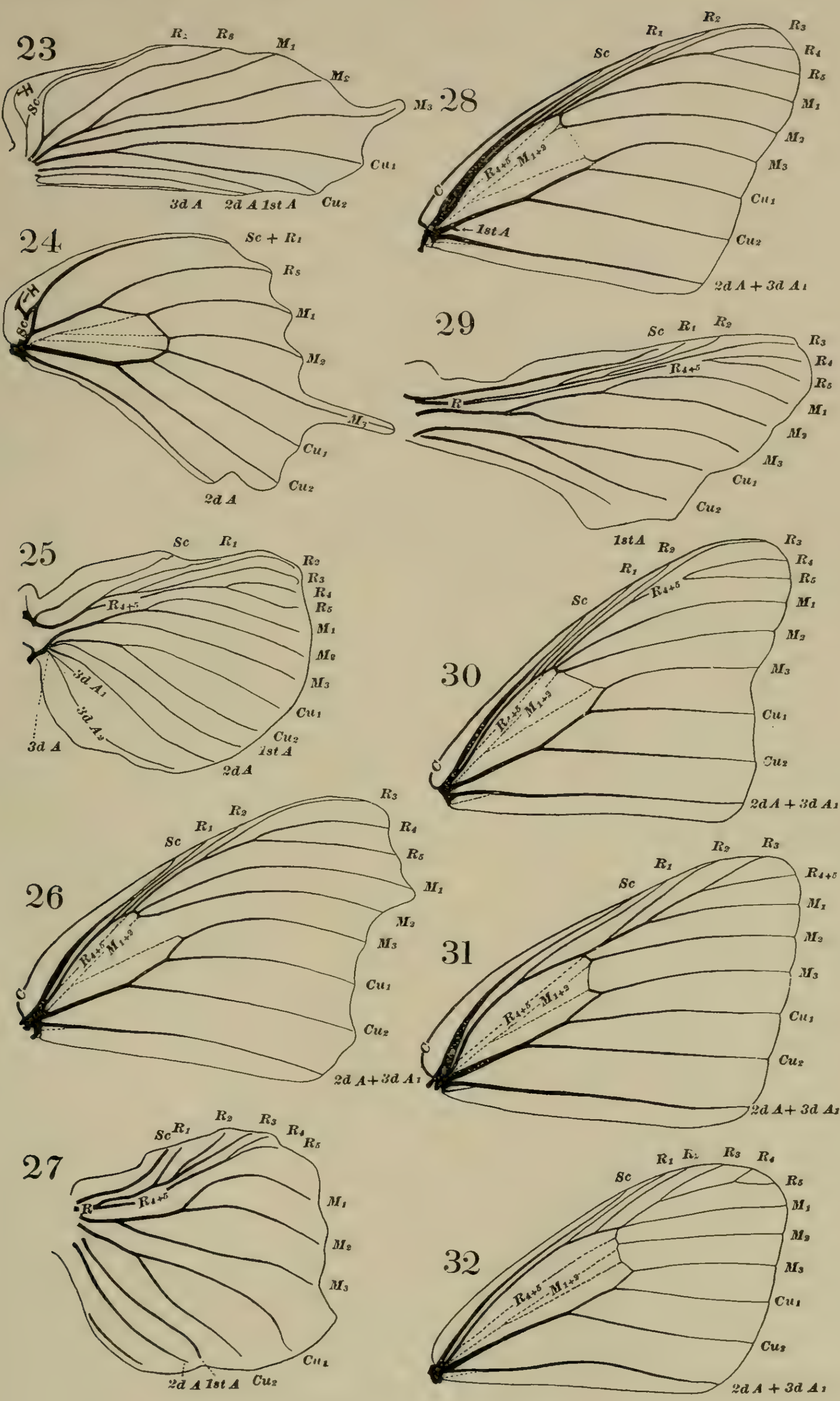

BUTTERFLY WING-VENATION.

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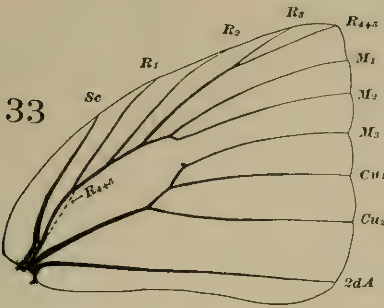

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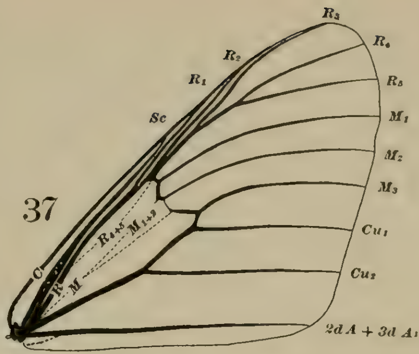

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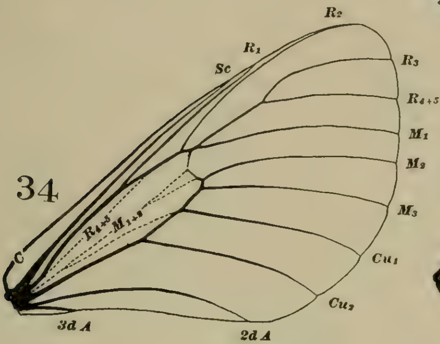

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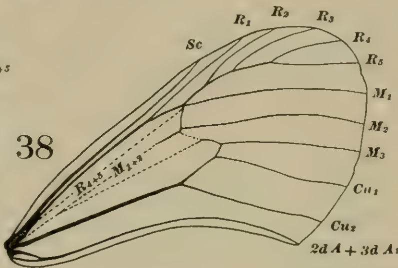

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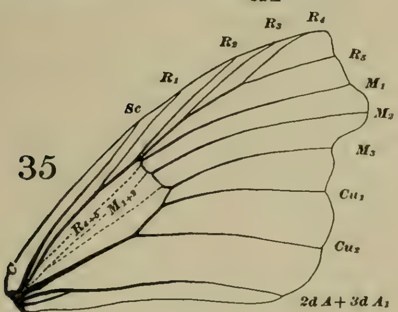

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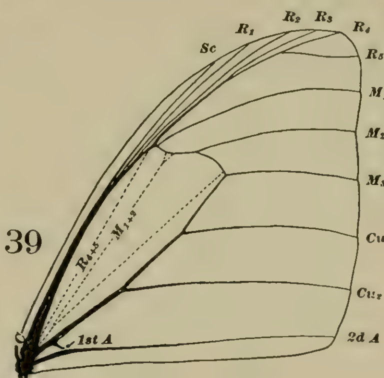

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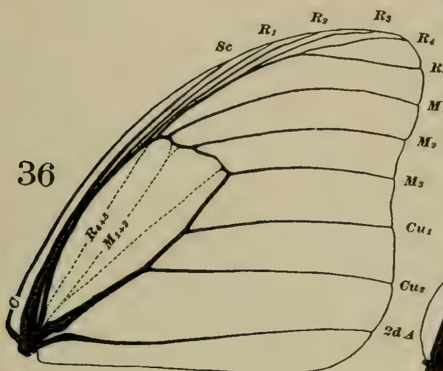

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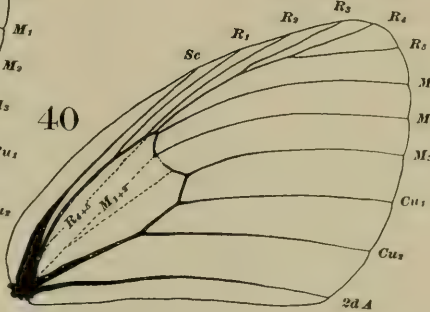

BUTTERFLY WING-VENATION.

SOME NOTEWORTHY EXTRA-EUROPEAN CYPRINIDS

By THEODORE GILL

In a former article on "The Family of Cyprinids and the Carp as its Type," were considered a few of the characters which serve to differentiate the Cyprinids from other fishes and which have been used to subdivide the family itself into minor groups. Furthermore, those species which bear names that have been transferred in America to other species were briefly noticed and illustrated. In the present article are introduced a few of the innumerable host occurring in America and other countries, which are conspicuous for various reasons.

American Cyprinids

In North America about 250 species of Cyprinids occur and almost all belong to genera or at least sub-genera unknown to Europe or Asia. The genus *Barbus,* so numerously represented in the old world, has not a single representative in the new, nor are any of the related ones represented. The genus that replaces it, so far as numbers go (and so far only), is *Notropis,* which includes about two-fifths of the American Cyprinids—over one hundred species; it belongs to the group called Leuciscinæ. The genus *Leuciscus* (*Squalius* of most European ichthyologists), as understood by Jordan and his disciples, is represented by about twenty-five species, the closely related *Rutilus* (*Leuciscus* of European ichthyologists) by four species, and *Abramis* by two. All the other American Cyprinids belong to genera peculiar to the "nearctic" or "arctamerican" region, but most of them belong to the group (*Leuciscinæ*) to which the bulk of the European Cyprinids do. Others have been referred to another ill-defined group ("*Chondrostominæ*") typified by European fishes. Still others ("*Mylopharodontinæ*") are closely related to the *Leuciscinæ* but have been differentiated from them on account of the preponderance of blunt or molar pharyngeal teeth. Better defined are three groups peculiar to America—the so-called "*Campostominæ,*" "*Exoglossinæ*" and "*Plagopterinæ.*" The systematic value of all these groups, however, remains to be discovered, and can only be realized after a thorough study of their anatomy.

Two of the characteristics of the American cyprinoid fauna are noteworthy: (1) The specialized character of the aggregate of

species, and (2) the comparative relations of the species to the old world faunas.

The isolation of America's cyprinoid fauna affords one of the many arguments against the association of all the northern faunas into one great realm or region variously designated as the triarctic, holarctic, and periarctic.

The American Cyprinids may be segregated under two geographical divisions, one including the species of the Atlantic slope as well as of the Mississippi Valley, and the other those of the Pacific slope. The former are the most characteristically American, the latter most nearly related to old world forms. It has long been maintained by botanists—by many at least—that there is a striking analogy on the one hand between the types of eastern America and eastern Asia, and on the other between those of western America and western Europe. Some features of the fish faunas might seem to support such a contention, but a more critical consideration of the evidence leads to a different conclusion. The fauna of Europe extends eastward into Asia and the resemblance between the fish faunas of western America and Europe is simply due to that fact and to the approximation of the two continents toward the north.

Another noteworthy circumstance is the large size which many of the Cyprinids of the Pacific slope attain, in this respect rivaling old world species, and contrasting with those of the cismontane regions. On the other hand, almost all of the numerous Cyprinids, not only of the streams of the Atlantic slope, but of the great Missippi Valley, are of small size, only a couple of species under ordinary circumstances reaching a length of a foot. The large Cyprinids of Europe are to some extent replaced by the Catosomids (suckers) of America.

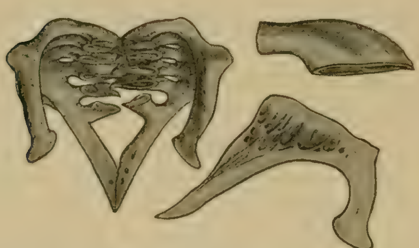

FIG. 36.—Pharyngeal bones and teeth of *Chondrostoma nasus*. After Heckel.

In more detail, none of the American species have three rows of pharyngeal teeth as most of the old world forms have. Further, a rather striking feature is the reduction in the number of pharyngeal teeth in the main row; the European species generally have five (in very few less) while most of the American species have only four. The Chondrostomines of Europe have mostly six or

even seven, while the American representatives, with one exception (*Orthodon microlepidotus*) have only four or five.

Still another interesting coincidence is the development of barbels. The majority of the old world Cyprinids have two pairs of well developed supramaxillary barbels, while not one of the indigenous American species has as many and when barbels are developed in a single pair they are usually very small and even may be said to be obsolete.

The great majority of the American Cyprinids, as already indicated, belong to the same great group (Leuciscines) as the majority of the European, and have the same kind of lips, pharyngeal teeth, alimentary canal, and dorsal and ventral fins. No distinction can be maintained between them and the Abramidines or breams. Indeed so little difference is manifest between them that an eminent ichthyologist on one occasion mistook for a variety of the American bream or common shiner (*Abramis* or *Notemigonus chrysoleucas*) a fish which he afterwards ascertained to be an escaped individual of the English Rudd. This case gives an example of the closeness of observation which is requisite to properly determine the species of the family.

Only a few of the more common or otherwise noteworthy species can be noticed here.

First some of the eastern Leuciscines may be considered.

Atlantic and Gulf Slope Cyprinids

The most characteristic American genus, so far at least as number of species goes, is one now generally named *Notropis* and comprising a large number of species (about a hundred) mostly confounded under the general designation of minnows. In common with a number of other American genera it has a main row of only four teeth on each pharyngeal bone, and sometimes only those four, but in most of the species there is a second row of one or two teeth; most of these are of the "prehensile" or "hooked" type (Greifzähne Heckel called them), and have either a very narrow grinding surface or none at all; the jaws have thin lips and no barbels, and the scales are rather large. Such is the "genus" as recognized by Jordan and Evermann, but their arrangement must be regarded as only provisional. They admit a number of sections or subgenera—a dozen—and several are worthy of notice.

The typical section—*Notropis* proper—has scales loosely imbricated and of regular form, and the teeth are in two rows (2, 4—

4, 2) and sharp-edged or without grinding surfaces. More than a score of species are recognized by Jordan and Evermann. The type and best known is the *Notropis atherinoides,* "the largest and

FIG. 37.—*Notropis atherinoides.* After Agassiz.

handsomest species" of the section; it occasionally attains a length of six inches and is "abundant in lakes, quiet places and river channels" in the Great Lake basin as well as in the Ohio and Mississippi valleys.

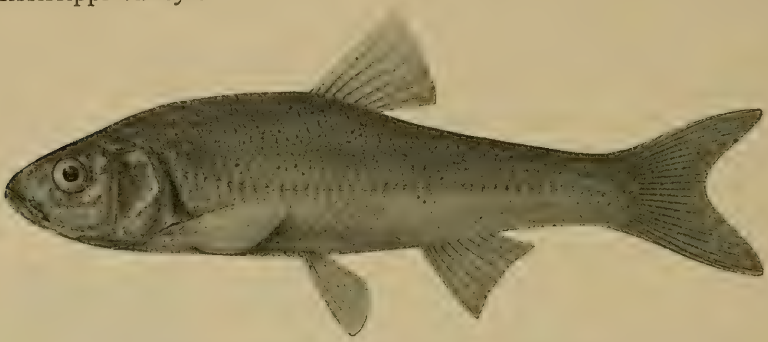

FIG. 38.—*Notropis cornutus,* female. After Baird.

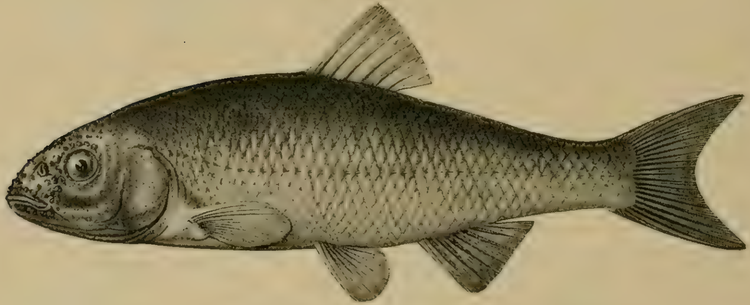

FIG. 39.—*Notropis cornutus,* male. After Agassiz.

Another and one of the best marked sections has been designated as *Luxilus.* It is distinguished by the high and closely imbricated scales so that the exposed portions are unusually narrow in propor-

tion to their height; a second row of pharyngeal teeth is developed and most of the teeth have narrow grinding surfaces. The species (about four) are comparatively large and the largest and best known is the *Notropis cornutus.*

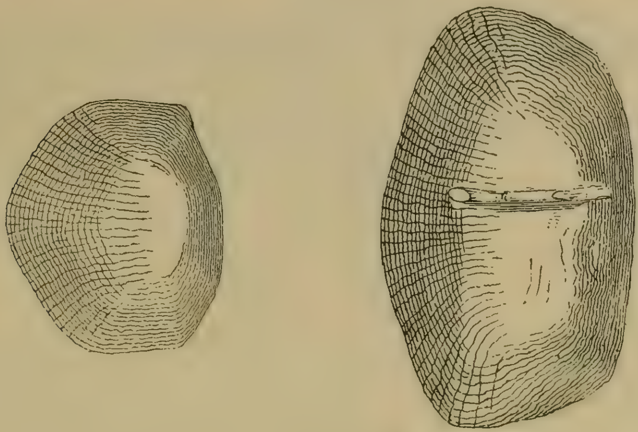

FIG. 40.—Scales of *Notropis cornutus.* After Baird.

The *Notropis cornutus* is most generally known as the redfin; other names shared with other fishes are dace and shiner. It is one of the largest of its genus, reaching a length of five to eight inches, and is one of the most abundant wherever found. It is often a companion of the common shiner (*Abramis—Notemigonus—chrysoleucas*). The color is steel-blue above, but in the spring the males become conspicuous for their gay attire, red or rosy lower fins, and tuberculated head; it is allusion to these tubercles, reminding one or horns, that the name *cornutus* involves. It is frequently caught by the angler for small fishes.

FIG. 41.—*Notropis hudsonius.*

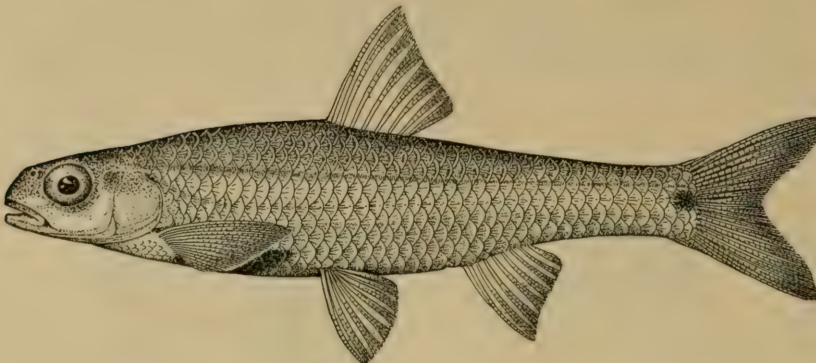

FIG. 42.—*Notropis hudsonius.* After Jordan and Evermann.

A third section (*Hudsonius*) includes fishes with large and normally formed scales, which are regularly imbricated; pharyngeal teeth, besides the main row (four), are generally existent to the number of one or rarely two in a second, but there is considerable variation in this respect (1, 4—4, 0 or 1, 4—4, 1 or 1, 4—4, 2 or 2, 4—4, 1). About a dozen species are known, the most notable being the *Notropis hudsonius* which has received such names as spawneater and spot-tail, and shares with many others those of minnow and shiner. It reaches a maximum length of six inches. While especially "abundant in the Great Lakes, and not rare east of the Alleghany Mountains," it also extends westward to Dakota and southward to South Carolina. It is known to many as "the choice live bait of the St. Lawrence angler," and fishermen along the Hudson commemorate, in a name they have given to it (spawneater), the belief that it is especially injurious to the spawn of more valued fishes.

Most of the numerous other species of *Notropis,* confounded under the general name of minnows, are much smaller than those mentioned.

Another interesting American Cyprinid, related to *Notropis* but "one of the most remarkable of our little minnows," is the *Ericymba buccata,* which nevertheless appears to have no distinctive vernacular name and is merely one of the host confounded under the designation of minnow. The species is distinguished from all others by the porous or cavernous condition of many of the head bones, especially the lower jaw, interopercular and suborbital bones, and the swollen appearance of the tunnels or channels perforated by the pores. It is to this condition that the name *Ericymba* refers, it being derived

from the Greek intensive particle ἐρι and the noun κύμβη, cavity. The species is pretty wide spread in the country watered by the northern and eastern affluents of the Mississippi and extends northward into Michigan and southward into West Florida, and where

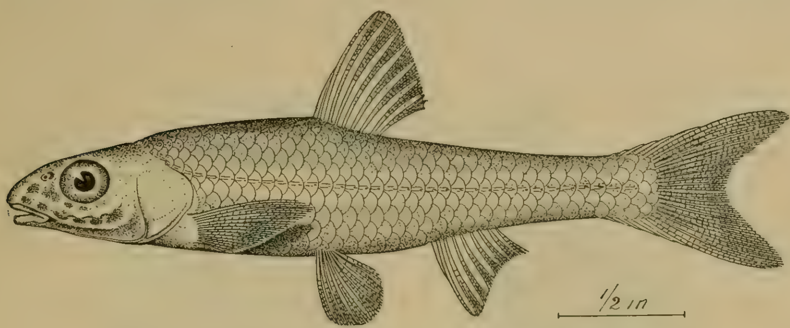

FIG. 43.—*Ericymba buccata.* After Jordan and Evermann.

it does occur, is tolerably common and "locally very abundant." It rarely attains a length of five inches.

The interest of this genus is in the fact that it repeats in the family of Cyprinids a characteristic which is manifest in isolated genera of a number of other families, but notably in the fresh-water Percids (as in *Acerina* or *Cernua*) and Cichlids (as in the *Trematocara* of Lake Tanganyika). It will be an interesting study for future naturalists to investigate the correlation between this structural feature

FIG. 44.—Horny Head, *Hybopsis kentuckiensis.* After Goode.

and habits and to ascertain whether the analogous structures are adaptive to identical or different conditions. Cope evidently assigned too much relative importance to the character by giving to it subfamily rank and isolating the genus from all others.

Closely related to *Notropis* is the genus *Hybopsis* which includes nearly a score (seventeen) of species. Like *Notropis* it has a principal row of four pharyngeal teeth, and in some a single tooth represents a second row, but sometimes there is none (4—4 or 1, 4—4, 1 or 1, 4—4, 0), and the teeth are essentially like those of *Notropis;* it differs from the kindred genus by the development of a barbel at the end of each maxillary bone.

The best known species is the *Hybopsis kentuckiensis,* popularly known as the horny-head, jerker, river chub, and Indian chub. It ranges from "Pennsylvania to Wyoming and Alabama, on both

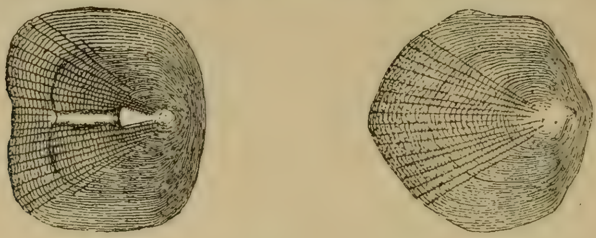

FIG. 45.—Scales of *Semotilus atromaculatus.* After Baird.

sides of the Alleghanies" and is "everywhere abundant in the larger streams, seldom ascending small brooks." It rarely attains a length of nine inches.

The genus containing the largest eastern American species is named *Semotilus* and differs from *Leuciscus* mainly in the fact that there is a little skinny flap called a barbel—and a very little one it is—near the hinder end of each upper jaw or supramaxillary bone, and the dorsal fin is a little farther back; the pharyngeal teeth of one side are also reduced in number (2, 5—4, 2).

FIG. 46.—Pharyngeal bones and teeth of *Semotilus.* After Baird.

There are two very distinct species (*S. atromaculatus* and *S. corporalis*), mostly designated as chubs in the eastern states, but also known as dace and by various other names. A third more southern form (*S. thoreauianus*) is scarcely distinguishable from the *S. atromaculatus.*

The fish generally called chub or, more specifically, silver chub, in the eastern states or New England and the Middle States, is a fish also named corporal, windfish, and fall-fish. Besides these, other English names given to Cyprinids have been misplaced upon

it, as cheven or chivin (an English synonym of chub), dace, and roach. Its scientific name is *Semotilus corporalis.* It is by far the largest of the Eastern American Cyprinids and sometimes reaches the length of eighteen or even twenty inches, although one twelve inches long is regarded as a good sized fish. It prefers clear

FIG. 47.—*Semotilus corporalis,* young. After Fowler.

swift streams and affords considerable sport to the angler. When young it has quite a different appearance from the adult, being marked with a distinct lateral band and the form of the head is also different.

A related species distinguished by the black spot at the base of the dorsal is the *Semotilus atromaculatus,* known as the creek chub

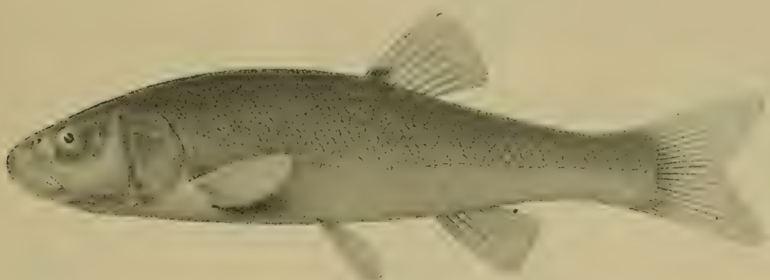

FIG. 48.—*Semotilus atromaculatus.* After Baird.

or horned dace. This has been closely observed in the spawning season by Professor Reighard, but no complete record of his observations has been published.

Both of these "chubs" are rather omnivorous feeders. They catch small fishes that come in the way, and also crawfishes, but depend mainly on insects and entomostraceous crustaceans as well as worms. A further considerable percentage of the food consists of filamentous algæ and vegetable debris.

Considerable difference of opinion prevails as to the gustatory quality of the chub. The opinion of Thoreau—"it is a soft fish, and tastes like brown paper salted"—has been often quoted. In

opposition to this the fish commissioner of Canada (E. F. Prince) declares (1905)[1] that "Thoreau was very far astray" and that the fish's "flesh is white," though "not quite as white as the whitefish, and of a delicate flavour, the bones being far less troublesome"

FIG. 49.—*Semotilus corporalis.* After Storer.

than those of "its near allies, the suckers." Prince had "known it (wittingly or unwittingly) served up as whitefish at sportsmen's clubs," and in Canada it is frequently called whitefish.

Another type related to *Leuciscus* and still more to *Semotilus* has been named *Platygobio* to commemorate one of the chief distinctions, the broad flattish head; the teeth are biserial but in reduced number (2, 4—4, 2) and have narrowed grinding surfaces; maxillary barbels are well developed. Three species are known and the best known is the *Platygobio gracilis,* designated as the flathead

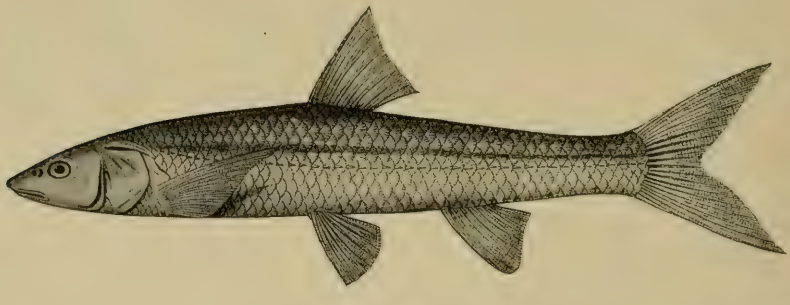

FIG. 50.—*Platygobio gracilis.* After Gill.

chub. Its range is from the east slope of the Rocky Mountains to the Saskatchewan River, and it is "abundant in river channels as far south as Kansas City, not ascending to springs." It attains a length of a foot.

[1] Twenty-seventh An. Rep. Dep't Marine and Fish.—Fisheries, p. lxxviii.

FIG. 51.—Pharyngeal bones, teeth, and scales of *Platygobio gracilis*. After Gill.

The shiner of many parts of the United States (*Abramis*—or *Notemigonus*—*chrysoleucas*) is most nearly related to the common bream of Europe, but instead of bearing that name, has had forced on it those of the English roach and dace. It is one of the commonest of the American Cyprinids and reaches a larger size than most of the others—often as much as six inches and occasionally, it is claimed, even a foot in length.[1] It affects mostly grassy or reedy waters and is generally to be found in mill-ponds. It is often angled for and readily takes a hook baited with an ordinary earthworm.

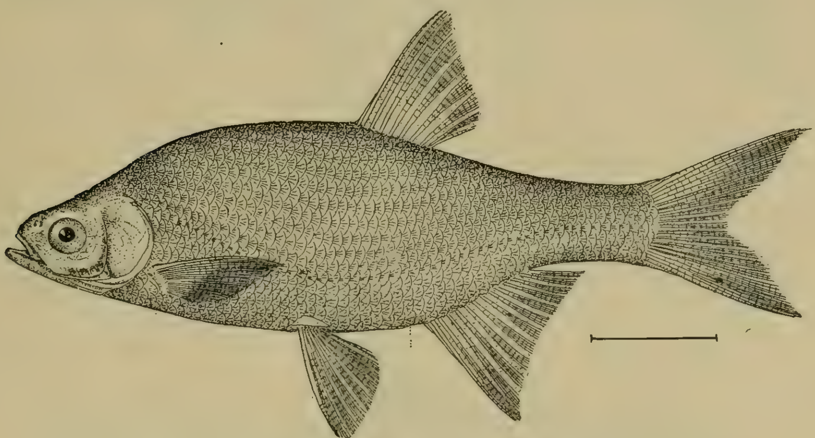

FIG. 52.—*Abramis chrysoleucas*. After Goode.

By Storer "it is said to be a delicate fish for the table," but it is really scarcely, if any, better than any other Cyprinid of the same size. It was more aptly said by him to be "the best bait" for pickerel in Massachusetts. It is not likely, indeed, that the pickerel exercises choice, but simply that, because of its size, abundance and facility of obtainment, it is the most used.

[1] The largest of thousands the present writer has caught or seen was barely ten inches long.

Dace is a name given in the United States to many different Cyprinids, but in the vicinity of Washington and many other places it is applied to the species of *Rhinichthys,* another genus peculiar to America and not very nearly related to any other. The name is

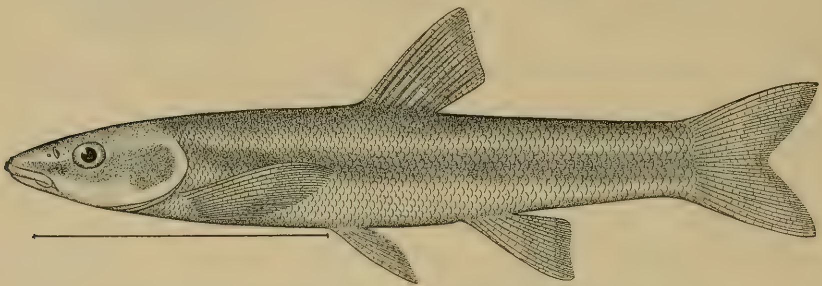

FIG. 53.—*Rhinichthys dulcis.* After Jordan and Evermann.

often extended into black-nosed dace. The few species are distinguished by a projecting snout, inferior mouth, dark color, and generally a darker longitudinal lateral stripe on each side; in the breeding season, however, the males assume a brilliant dress, becoming more or less suffused with crimson. They are active little fishes, preferring clear running streams, and are much used for bait for larger fishes. They prepare a nest of stones for the reception of the eggs, which is taken charge of by the male.

Data respecting the habits of *Rhinichthys atronasus* are given by C. N. Holder in Harper's *New Monthly Magazine* for December, 1883 (Vol. 68, pp. 100–103, under the typographical misnomer *Rhynchichthys abronasus*), and by C. C. Abbott in 1884 in "A

FIG. 54.—*Rhinichthys atronasus.* After Storer.

Naturalist's Rambles about Home" (pp. 419, 420). This is a small species about three inches long. A larger one, about five inches long, has a more prominent snout and was therefore named by the old ichthyologists *R. nasutus,* but a still older name—*cataractæ*—has

been revived by recent authors for the species. The latter name was given because the type specimens were found about Niagara Falls; its favorite resorts are also indicated by the name, for it largely resorts to rapids and swift running streams.

A characteristic eastern American genus named *Hybognathus* has been referred to the Chondrostomines because it has an elongated alimentary canal (three to ten times as long as the body), but otherwise it is not like the typical members of the group. The jaws are

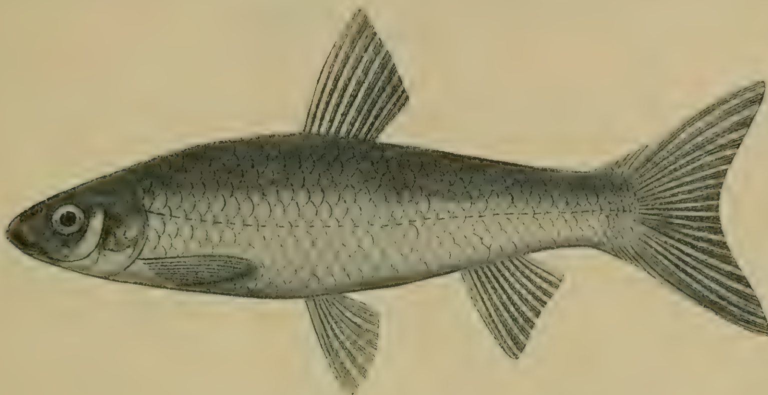

FIG. 55.—*Hybognathus nuchalis.* After Fowler.

sharp-edged and without corneous coverings and the pharyngeal teeth are uniserial (4—4), cultriform, and nearly straight. The gudgeon of the vicinity of Washington is the type of the genus. That type (*Hybognathus nuchalis*) is a fish with large scales, often about six inches long, of an olivaceous green color, with silvery sides and almost translucent. This style of coloration has also gained for it the name of smelt. It is much angled for from the wharves and shore-walls of Washington and is also used for bait.

There are a couple of genera well marked as such, but otherwise possessing no salient external peculiarities that arrest immediate attention, which on closer examination are discovered to have quite exceptional characters; they have been named *Campostoma* and *Exoglossum.* Both of them were set apart many years ago (in 1866) by E. D. Cope as the types of independent sub-families which he named Mesocysti and Cochlobori, but for which those of Campostominæ and Exoglossinæ have been substituted by later American ichthyologists.

The Campostomines, although having a somewhat peculiar physiognomy, present no external features which would lead one to

suspect any great internal differences or that they were very distinct from minnows or chubs. The mouth and mouth parts are normal.

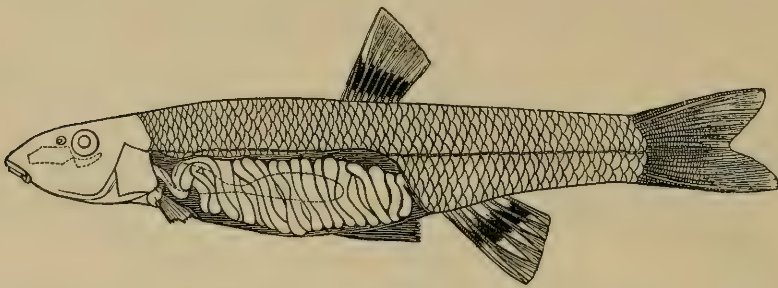

FIG. 56.—*Campostoma anomalum,* showing the air-bladder (in outline) involved in the circumvolutions of the alimentary canal. After Cope.

Dissection, nevertheless, reveals a strange and otherwise unexampled condition of the viscera.

The intestinal canal is extremely elongated and it goes out of its regular course to involve the air-bladder and surround it with many coils, and within these coils are also involved even the gonads (ovaries of the females and spermaries of the males). This arrangement contrasts strongly with that manifest in other Cyprinids and, in fact, in all other teleost fishes, in which the air-bladder (when present) is next to the roof of the abdominal cavity.

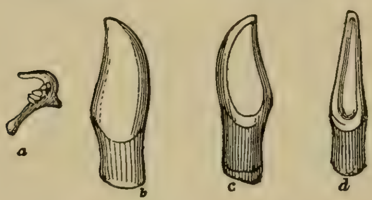

FIG. 57.—Teeth of *Campostoma anomalum.* After Agassiz.

The only genus, *Campostoma,* according to Jordan and Evermann, has four species, fishes of moderate size as American Cyprinids go

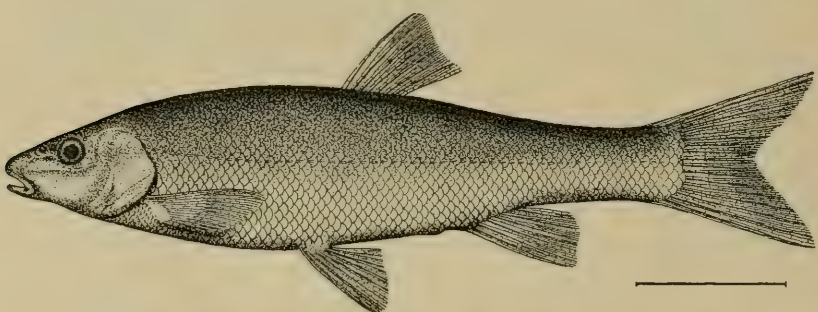

FIG. 58.—*Campostoma anomalum.* After Jordan and Evermann.

(up to about eight inches), and which range from New York to Mexico; in other words they occur in the streams tributary, directly as well as indirectly, to the Mississippi basin, and in those discharging west of it in the Gulf of Mexico, but not in those of the Atlantic seaboard. The best known species is the *Campostoma anomalum* which ranges from central New York to Tennessee, Texas and Wyoming, and was found by Jordan and Evermann to be "everywhere abundant in deep or still places in small streams, running up small brooks to spawn in spring." It brings stones together into a nest and is known popularly as the stone-roller.

FIG. 59.—Cut-lips Minnow, *Exoglossum maxillingua*. After Fowler.

The Exoglossines, although in general appearance like the ordinary minnows, manifest a certain peculiarity in physiognomy which is soon found to result from the singularly shaped mouth, and especially the structure of the lower jaw. The peculiarity of structure was first recognized by Cope (1866) who correctly described the foremost or principal elements of the lower jaw, "dentary bones, straight and flat, united together throughout their length"; thus modified, they simulate a tongue, and to this the name *Exoglossum* (ἔξω, outside, and γλῶσσα, tongue) alludes. The tongue-like structure, however, has nothing to do with the true tongue unless it be to entail a recession of it backwards. As Cope has stated, "the incompletely defined body which in this family represents the tongue is situated in the back part of the oral cavity, since the glossohyal bone is excluded from its usual place, and is short; its approximation to the interopercle and ceratohyal, with the basihyal and strongly elongate urohyal, defend the lower surface of the head effectually."

The linguiform extension of the lower jaw is utilized for the pur-

pose of scraping shells from the rocks on which they are found. Mollusks form the principal food of the fishes and crushed shells may be almost any time found in the stomach. On account of the

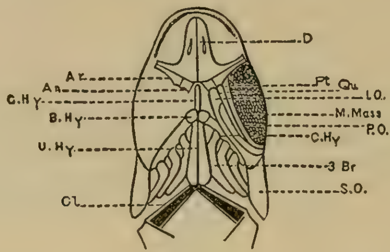

FIG. 60.—*Exoglossum maxillingua.* Lower bones. *An,* Angular; *Ar,* Articular; *B.Hy,* Basihyoid; *3Br,* Branchiostegal rays; *C.Hy,* Ceratohyoid; *Cl,* Clavicle Cœnosteon; *G.Hy,* Glossohyal; *IO,* Interopercular; *M.Mass,* Masseter Muscle; *P.O,* Preopercular; *Pt,* Pterygoid; *Qu,* Quadrate; *S.O,* Subopercular; *U.Hy,* Urohyoid. After Cope.

adaptation and food habits of the type the name Cochlobori (shellfish-eaters) was given to the subfamily by Cope.

The *Exoglossum maxillingua* is the only common and naturally the best known species of the group, and is sufficiently large and conspicuous to have received a number of popular names, such as cut-lips, day chub, nigger chub, and nigger dick, the first, of course,

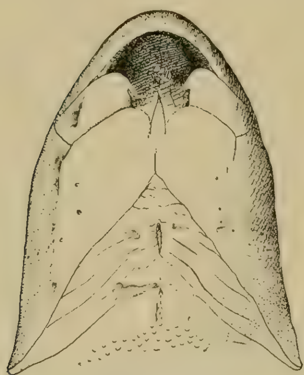

FIG. 61.—Lip of *Exoglossum maxillingua.* After Jordan and Evermann.

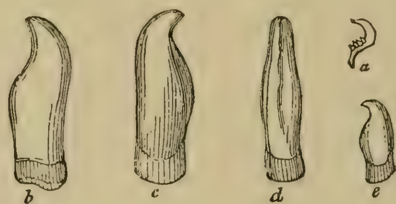

FIG. 62.—Teeth of *Exoglossum.* After Agassiz.

recalling the trenchant lower jaw and the last two the dark color. Its geographical range is from the St. Lawrence basin and Lakes Ontario and Champlain southwards into Virginia. It is, as Jordan

and Evermann remark, "abundant in the basins of the Susquehanna, Hudson, Potomac, James, Roanoke and Kanawha, but not widely distributed." Its ordinary length is about five or six inches.

Another interesting type of very limited distribution is that designated as the Plagopterinæ or Medinæ. These are small fishes distinguished by the structure of the dorsal and ventral fins. The ven-

FIG. 63.—*Plagopterus argentissimus.* After Cope.

tral and the anterior dorsal rays are peculiarly modified. The dorsal has a first spine which is short and slender or rudimentary and this is followed by a large compressed one furrowed behind and closely pressed upon by a smaller third spine. The ventrals are still more modified from the ordinary cyprinoid types: the innermost rays are

FIG. 64.—*Lepidomeda vittata.* After Cope.

tied to the body by a membrane extending along most of the length of the ray and all are more or less compressed and inarticulate at base, but from their inner edges branched and articulated raylets divaricate, the whole reminding one of a flat chip whose edge has been partly slivered off.

FIG. 65.—*Lepidomeda vittata.* After Cope.

Two of the species have perfectly naked bodies and are very closely related, but nevertheless are distinguished by the presence or absence of barbels and have consequently been referred to different genera—*Meda* and *Plagopterus*.

The longest known species is the *Meda fulgida* which has no barbels. It is a little fish rarely exceeding two inches in length and of a bright silvery color. It was found by C. H. Gilbert and N. B. Scofield (1898) to be " extremely abundant in the upper course of the Rio Verde, near Chino," and occurs elsewhere in Arizona.

Pacific Slope Cyprinids

As already indicated (p. 298), the cyprinoid fauna of the streams and lakes of the Pacific slope has many features in common with that of Europe, and the English angler might recognize, in the objects of his capture, forms that he had been familiar with from youth. He would, probably, even be inclined to call one or more chub, and the chub genus—*Leuciscus*—is represented by a number of species. None of the species, indeed, are closely related and all belong to sections or subgenera peculiar to America, but the differences are so slight as to justify their union in the same genus.

The common " chub " of the San Francisco and Sacramento markets is the sole representative of a peculiar section (*Siboma*) and is conspicuous for the massive appearance of the caudal peduncle from a side view, and to this the name *L. crassicauda* alludes; it is very much compressed and high, squeezed out, as it were, upwards and downwards; the scales are comparatively large and well imbricated (50–56 along the lateral line); the pharyngeal teeth are generally in unequal number on the opposite sides (2, 4—5, 2); the color of the back is brown and of the sides white, but the scales generally are dotted with dark. Its ordinary length is about a foot. It is caught in large quantities and is a staple market fish but chiefly utilized by the Chinese.

Another very common species is the " chub of Utah Lake," or the " great chub " common in the streams of the plateaux and bottoms of the Rocky Mountains—the *Leuciscus lineatus* of recent ichthyology. It is typical of a group of species (*Tigoma*) characterized by small or moderate-sized scales which are less imbricated than usual; the pharyngeal teeth are essentially like those of *Leuciscus crassicauda*. The color is very dark—blackened—and this darkness extends to sides and belly even, especially about the edges of the scales, for the centers are somewhat paler; this arrangement of colors has given rise to the rather misleading scientific name

(*lineatus*) of the species. Otherwise, as Jordan and Evermann add, the species "varies greatly with age and surroundings." It grows

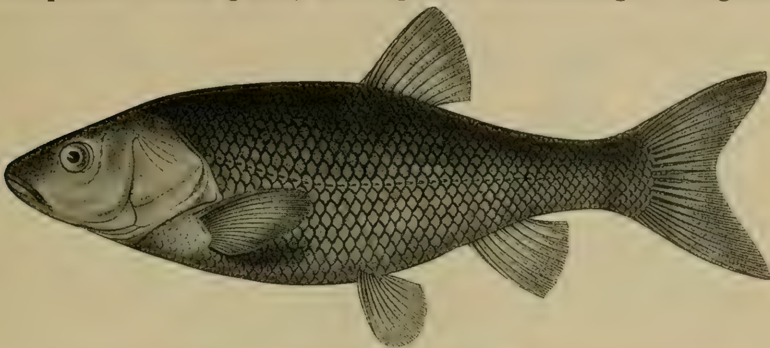

FIG. 66.—Chub of Utah Lake, *Leuciscus lineatus*. After Gill.

to a length of a foot or more—at least to fifteen inches occasionally. According to Jordan (1884) it "is excessively abundant in Utah Lake and, as it ascends the streams to spawn almost simultaneously with the trout (*Salmo mykiss clarkii?*), it is extremely destructive to the young of the latter. It is taken in considerable number in seines, and is sold in the markets of Salt Lake City and other towns.

Rather nearly related to the chubs and daces is a genus whose head-quarters are in the Gila river and from this it has derived its name (*Gila*). The physiognomy of the fishes is characteristic, the caudal peduncle being exceptionally slender and elongate; the caudal fin is deeply forked and enlarged by rudimentary or fulcrum-like rays which increase its extent above and below the peduncle; the scales

FIG. 67.—*Gila elegans*. After Girard.

are very small and barely imbricated; the head is broad and the snout prominent; otherwise it is essentially like the chubs and has pharyngeal teeth of the same general type as the *Tigomas* (2, 5—4, 2).

As Jordan (1883) has remarked, "the various species of *Gila* abound in the basin of the Rio Colorado and Rio Gila, and are used as food in New Mexico and Arizona. They reach a length of about eighteen inches."

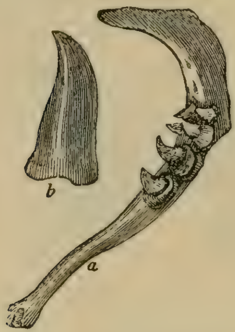

FIG. 68. — Pharyngeal bones and tooth of *Ptychocheilus major*. After Agassiz.

Another of the Leuciscine genera characteristics of Pacific America is that called *Ptychocheilus,* whose species have an appearance somewhat intermediate between chubs and gilas; the head is long, the snout prolonged, and the mouth deeply cleft and almost horizontal, thus somewhat resembling a pike whose name has been usurped for it by some of the inhabitants of its country. In accordance with its large mouth are the pharyngeal bones and teeth, the former elongate, the latter sharp-pointed and sharp-edged. Three species are generally recognized.

The largest of the American Cyprinids belong to the genus *Ptychocheilus,* one inhabiting the Colorado river (*P. lucius*), being locally known as the "salmon," and another (*P. oregonensis*) of Oregon and the Sacramento river being dubbed the "pike" or "squaw fish"; the former sometimes attains a length of five feet and a weight of eighty pounds and the latter is not very much smaller. They are rapacious animals with larger mouths than are possessed by any other American Cyprinids. Both are common

FIG. 69.—*Ptychocheilus oregonensis.* After Jordan and Evermann.

fishes in their respective regions and held in some esteem as marketable fishes. In Oregon, the species of its great river is very highly esteemed by the Indians, and is a rival in their favor of the salmons, and hence has been designated as the squaw-fish, a name which

has indeed come into quite general use. In the Sacramento basin, other names, besides pike, according to Jordan and Evermann, are " chub, pig-mouth, box-head, yellow-belly and chappaul."

A genus of the same general group and having the same form as the preceding is *Pogonichthys,* so named because, unlike all the

FIG. 70.—*Pogonichthys inæquilobus.* After Girard.

preceding, it has little skinny tags or barbels at the hinder ends of the upper jaw bones (one on each side) ; another peculiar character, developed in the adults, is a want of symmetry in the forked tail-fin, the upper lobe being much larger than the lower; furthermore, the fulcral or basal caudal rays are unusually developed. The scales are rather large (about 65 in lateral line) and well imbricated. Only one species is now recognized.

The split-tail is the name aptly given to the *Pogonichthys macrolepidotus.* Its ordinary length is about a foot, but some may attain

FIG. 71.—*Mylopharodon conocephalus.*

that of eighteen inches. According to Jordan (1883), it " is very common in the Sacramento, and is brought in considerable numbers to the San Francisco market."

All the preceding species of the Pacific coast have been universally recognized as Leuciscines; a couple of other west coast types resembling them in structure and form, as well as in the short intestinal canal, but differentiated by molariform pharyngeal teeth, have been

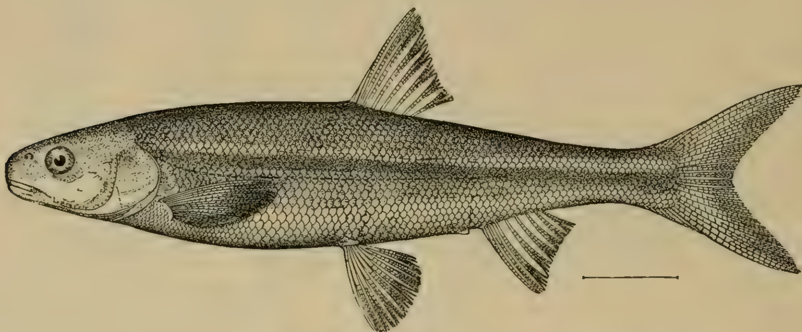

FIG. 72. *Mylocheilus lateralis.* After Jordan and Evermann.

segregated by Jordan and Evermann as the "*Mylopharodontinæ.*" Three genera have been established, two of which are noteworthy. Both of them have the teeth in two rows (2, 4—5, 2 or 2, 5—5, 2), and each is represented by a single species.

The *Mylocheilus lateralis* (miscalled *caurinus*) has the upper jaw slightly protractile and a small tag or barbel at the end of each maxillary. According to Jordan (1883), it "abounds from California to Puget Sound in all the streams of Oregon, Washington

FIG. 73.—*Chondrostoma nasus.* After Heckel and Kner.

and Idaho, and often enters the sea. It reaches the length of little more than a foot." It was formerly little used for food where trout and other fishes abound, but now, according to Jordan and Ever-

mann (1902), "it possesses some importance as a food-fish. At some places in the Columbia basin it is served as 'whitefish' at the hotels, and elsewhere it is peddled over the country as 'trout' or 'fresh-water herring.'" It is also esteemed as an angle-fish. "It takes the hook readily and possesses considerable game qualities. The best bait seems to be salmon spawn, but it will bite at almost anything."

The *Mylopharodon conocephalus* has the upper jaw fixed (not protractile) and is destitute of barbels. It occurs with the socalled pike (*Ptychocheilus oregonensis*) "in the Sacramento and is brought with it into the markets." It reaches a size scarcely less than that of its associate (two to three feet) "but is less plentiful," and does not extend beyond the Sacramento basin.

FIG. 74.—Head from below of *Chondrostoma nasus*. After Kner.

Three other Pacific slope Cyprinids are noteworthy because they belong to a group chiefly represented in the old world (*Chondrostomines*) distinguished by the elongated alimentary canal (which is more than twice as long as the body) and, in the typical forms, by a horny plate investing each jaw.

One of these (*Acrocheilus alutaceus*) has, like the typical Chondrostomines of Eurasia, a horny plate to each jaw which is very

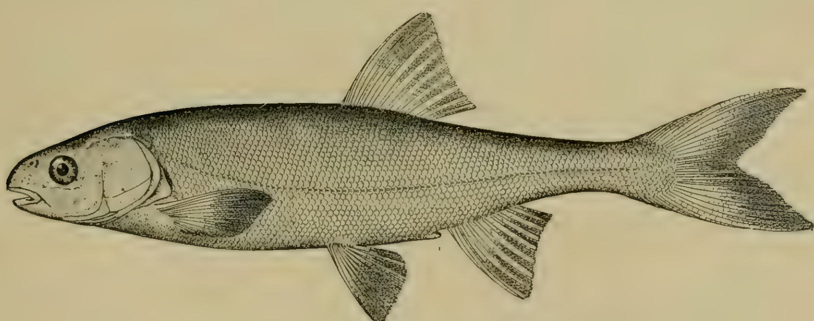

FIG. 75.—*Acrocheilus alutaceus*. After Jordan and Evermann.

conspicuous and sharp-edged. The structure or form of the lips and mouth have suggested the generic name (ακρος sharp, χειλος lip) as well as the vernacular names of the species (chisel-mouth, hard-mouth and square-mouth). It differs, however, by the reduced

number of pharyngeal teeth (4—5) which are hooked and have broad grinding surfaces.

It is a common fish in places in the "Lower Columbia River and tributaries, as far up as Spokane and Shoshone Falls." It is one of the many foot-long fishes. It is only eaten in lieu of better fishes.

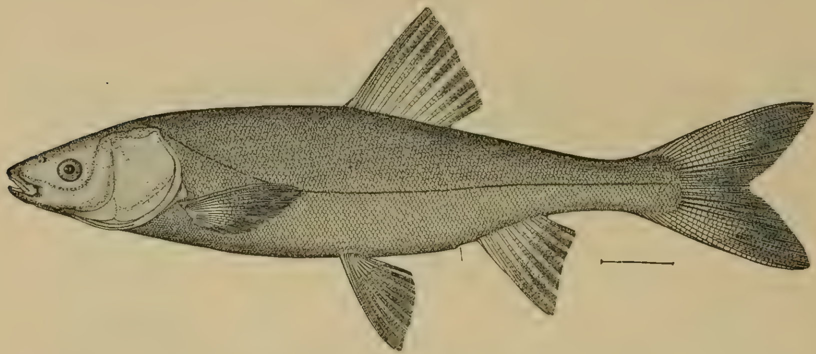

FIG. 76.—*Orthodon microlepidotus.* After Goode.

A second generic type (*Orthodon microlepidotus*) has no horny covering to the jaws, but the lower is sharp-edged and has a knob at its symphysis; in the number of pharyngeal teeth, however, it agrees better with the old world Chondrostomines (6—6 or 6—5); the teeth are lancet-like and nearly straight, and to this peculiarity the generic name refers (*ορθος*, straight, and *οδους*, tooth). The color is dark olivaceous but paler below—dark enough, however, for it to be called, as so many others have been, blackfish in California; of course this is a distinctive name only in its home, but no other has been recorded.

It ranges generally between a foot and a foot and a half in length and its size secures it a place in the markets. "A good many are sent to the market in San Francisco, where they are eaten by the Chinese."

The third of the so-called Chondrostomine fishes (*Lavinia exilicauda*) has no horny plates to the jaws and the lower jaw shuts within the upper. The pharyngeal teeth are uniserial (4—5 or 5—5) and cultriform with broad but shallow grinding surfaces. Like several of its compatriots its caudal fin is reinforced by a number of rudimentary or fulcrate rays procurrent above and below the peduncle. The peduncle is quite slender and it is to that slenderness that the specific name (*exilis,* slender, *cauda,* tail) refers. A foot

is the average length. It is, according to Jordan and Evermann, an inhabitant of the " streams of the Coast Range about San Francisco and Monterey, locally common as far north as Clear Lake." It is caught to some extent for the markets.

FIG. 77.—*Lavinia exilicauda.* After Girard.

Mexican Cyprinids

Cyprinids extend far down into Mexico in the streams of the tableland, but in diminishing numbers southwards, and are practically absent from the streams of the lowlands south of the Rio Grande valley. Altogether, about a half hundred (48) species occur in temperate Mexico, of which nearly half (23) are confined to the country and the rest (25) are common to it and southwestern United States. Two score species (40) occur in the valley of the Rio Grande and five in the Colorado river system. Five of the genera (*Xystrosus, Stypodon, Falcula, Aztecula* and *Evarra*) are restricted to Mexico, but are monotypic or represented by only two (*Evarra*) or three species (*Aztecula*). Further details may be found in Seth Meek's monograph on " The Fresh-water Fishes of Mexico " (1904).

Northern Asiatic Cyprinids

The cyprinoid fauna of northern Asia is simply an extension of the European fauna eastward or, more properly, there is a great Eurasiatic realm, extending from the Pacific to the Atlantic ocean and from the Himalaya mountains and isothermal regions northwards, which has a common fish fauna as well as continuous mammal and bird faunas. Many genera extend from one extreme to the other; for instance, *Leuciscus* and *Phoxinus,* the daces and minnows, are as prominent in Japan as in Britain.

The barbel genus (*Barbus*) is represented by at least three species in Palestine and one of them (*Barbus longiceps*) is quite closely related to the common barbel of Europe, but has the head, and especially the snout, more elongate, as the name (*longiceps* or long-

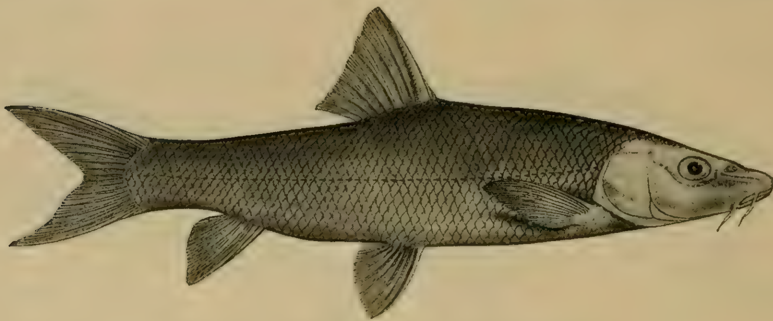

FIG. 78.—*Barbus longiceps*. After Tristram.

headed) indicates. This species is peculiar to the Lake of Galilee and the river Jordan and, according to Tristram (1884), "is one of the most abundant of the many abundant species in the Lake." It is noteworthy, too, that it is also "one of the best kinds for the table."'

A peculiar genus (*Capoeta*), related to the barbels, is distinguished by the transverse inferior mouth and by the branches of the

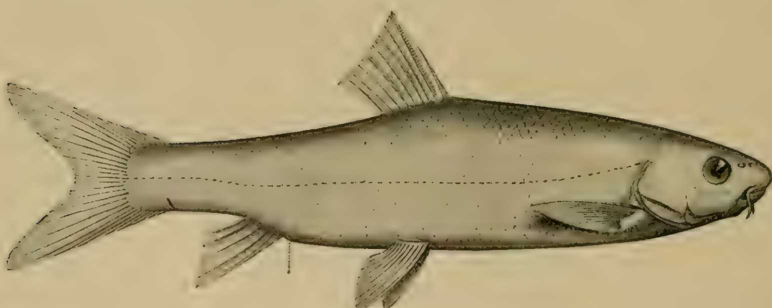

FIG. 79.—*Capoeta fratercula*. After Heckel.

lower bent inwards in front and with the anterior edge invested in a subcorneous sheath. It is richly represented by species from near the confines of Europe to Central Asia, and no less than seven species occur in Palestine. In that holy land one of the species (*Capoeta fratercula*) has become the recipient of exceptional atten-

tion. Tristram tells that "at the Algerian village of Deichûn, near Safed in Galilee, there is a large fountain full of this species. These fish are looked upon by the Arabs as sacred to Mohammed, and they will on no account allow any one to take them. A little to the north of Tripoli also, at the shrine of Sheikh el Bedawi, is a copious spring, with a large basin and streams flowing from it, choked with these fishes, which seem piled up in layers, with hardly space to move. They are an object of veneration, and are always fed by the worshipers. They follow in masses any visitor as he walks by the edge, gaping for food." This Capoeta is called by the Arabs *Semakh nahri* and is esteemed as one of the best fishes of Palestine. Tristram considers that "it is excellent eating, and its flesh is a pale pink colour."

Several of the other species of *Capoeta* (especially *C. damascina, C. syriaca* and *C. socialis*) are very abundant in the Lake of Gennasoret, the Sea of Galilee of the Bible. The *C. damascina* is equally abundant in the lower reaches of the Jordan and, according to Tristram Canon, is "carried down into the Dead Sea in great numbers, and perishes at once, strewing the north shore."

Another of the characteristic and very common fishes, but locally, of Syria, is a small species, a real minnow closely related to the European minnow and dace, but distinguished by the combination of the imperfect lateral line behind, the development of only nine anal rays, and the presence of only one row of pharyngeal teeth. It has been named *Leuciscus libani* as well as *Phoxinellus* and *Pseudo-*

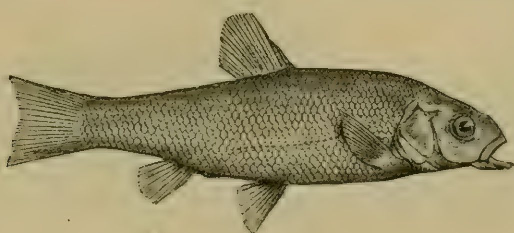

FIG. 80.—*Pseudophoxinus libani.* After Lortet.

phoxinus. It is "generally less than two inches long" and "rarely reaches two and one-half inches in length." It was "discovered by Dr. Lortet in the little lake of Yammûneh, a mountain tarn above Ainâta in Lebanon, well known to visitors to the Cedars from Bealbeck, and 4,800 feet above the sea. These little fishes, apparently the only inhabitants of the lake, at the season when the little streamlets of the tarn are at their fullest, crowd into them, and form an

important article of commerce for the villagers." The inhabitants of the little hamlet of Yammûuneh catch them by thousands of kilograms and sell them in the neighboring villages and convents for eight to ten cents a " battle " which is a measure of about five pounds.

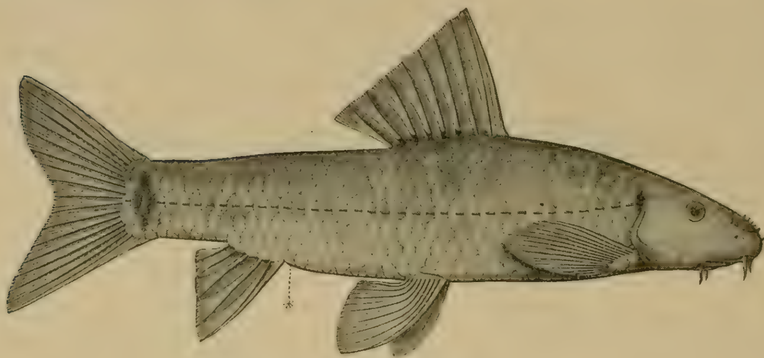

FIG. 81.—*Discognathus lamta,* female. After Heckel.

A characteristic Asiatic genus represented by a number of species is *Discognathus.* It is related to the barbels and, like the typical species of that genus, has two pairs of barbels and three rows of pharyngeal teeth, but the lip is transformed into a subcircular suctorial disk with free margins. The air-bladder is small, especially

FIG. 82.—*Discognathus lamta,* male. After Day.

its hinder portion. The males of the lamta, in the height of the breeding season, may develop a remarkable subfrontal prominence and this, as well as the snout, is beset with spiniform tubercles. A singular appearance is thus imparted to the head and, as the mouth is inferior and concealed from observation, one might mistake, at first glance, the cleft between the frontal prominence and snout for the mouth. Females have the ordinary barbel-like head and the

contrast between them and males is very striking. The lamta (*Discognathus lamta*) has a wide range in Asia, ranging from Syria into India and still further eastward, and is common in the affluents of the Jordan and the Lake of Gennesaret; it also extends into Abys-

Female. After Heckel. Male. After Day.
FIG. 83.—*Discognathus lamta.*

sinia. It rarely grows to more than six to eight inches long. According to Day, it putrifies very rapidly after death, and generally dies almost as soon as removed from water.

PECULIAR UPLAND CYPRINIDS.

In streams of the great mountain regions, the Himalayas and their outliers, isolating India from the rest of Asia, are to be found peculiar fishes which have been combined in a group named (by McClelland) "Schizothoracinæ." The group includes fishes having the same general form as the barbels, and indeed called hill-barbels,

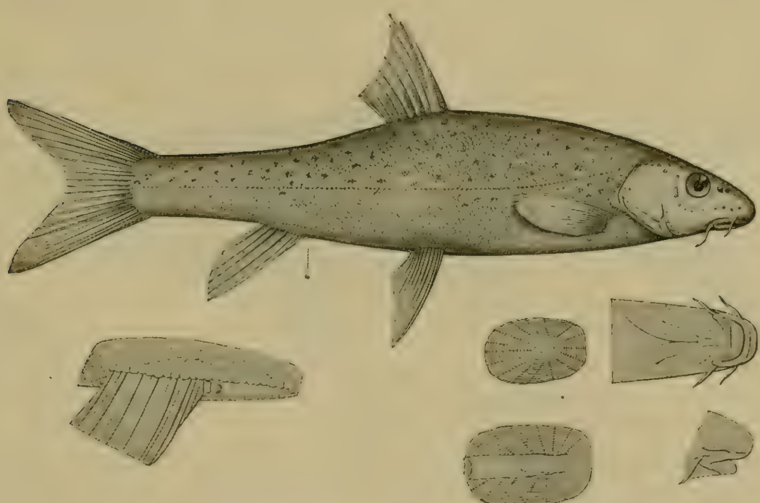

FIG. 84.—*Schizothorax sinnatus.* After Heckel.

but distinguished by a remarkable type of squamation. Above and on each side of the anus and anal fin is a band of enlarged scales differentiated from the others and forming a kind of sheath into which the base of the anal fin is concealed. In other respects there is little difference from the true barbels; there are, as in them, three rows of pharyngeal teeth in the typical forms, but in others there are only two; the number of barbels varies, some species having four, others two, and the remaining none.

About fifty species representing ten or a dozen genera are known, the principal being *Schizothorax,* which contains about a score of species.

Species of this genus are very voracious. J. McClelland (1838) claimed "that it is no uncommon thing to find" one "so overgorged that the tail of its prey remains protruding from the mouth, to be swallowed after that portion which is capable of being received into the capacious stomach is sufficiently digested to admit of the introduction of the remainder." He had seen fishes "so often in this state" that he presumed "they are easier caught in it than in any other."

Some Chinese Cyprinids.

Another type is noteworthy on account of the singularity of appearance as well as the size of the few species. The forehead or interorbital region is high upraised and arched, and consequently the eyes are abnormally low down on the sides. This inferior position of the eyes has given name to the genus (*Hypophthalmichthys*)

Fig. 85.—*Hypophthalmichthys nobilis.* After Steindachner.

and group or sub-family which it represents (Hypothalmichthyines). Another remarkable peculiarity is the structure of the gill-rakers in association with a peculiar superbranchial shell-like organ which

has been described and illustrated by Boulenger (1901). The genus is represented by about eight species occurring in various waters of Central and Eastern Asia. The largest and best known of these are the Chinese *H. molitrix* and *H. nobilis.*

The *Hypophthalmichthys molitrix* is an inhabitant of China, where it is known as the Lenhi; it sometimes attains a large size—between three and four feet.[1] It is highly esteemed as a food fish, and is the object of a considerable pisciculture, not only in China, but by Chinese beyond the borders of their country. According to Mitsukuri (1905) the Chinese of Formosa import the young, "when nine to ten inches long," from China "in November and December," place them in ponds where they are "abundantly fed," and when they have become a "foot long" they are ready for market. The "fish is cultivated in all parts of Formosa."

FIG. 86.—Pharyngeal bones of *Hypophthalmichthys.* After Steindachner.

The clupeiform Cyprinids typified by the European sichling (*Pelecus cultratus*) are represented by Chinese fishes distinguished from *Pelecus* by the development of three rows of pharyngeal teeth (5 or 4, 4, 2—2, 4, 4 or 5). *Parapelecus argenteus* and *P. machærius* are species.

JAPANESE CYPRINIDS.

As already indicated, the Cyprinoid fauna of Japan is in its general features essentially similar to that of Britain and the rest of western Europe, that is, it is part of one and the same great "eurasiatic" or "palæarctic" realm, but an entirely distinct subordinate region. The fullest exposition of its character has been given by David S. Jordan and Henry W. Fowler in "a review of the Cyprinoid fishes of Japan," published in 1903 (Proc. U. S. Nat. Mus., XXVI, 811–862). Then thirty-four species representing twenty-one genera were recognized. Most of the genera are monotypic and peculiar to Japan and China, but others are shared with Europe. Cyprinines (*Cyprinus* and *Corassius*), in the persons of the common and Prussian carps, are in both extremes in a state of domestication. The carp "has run into many varieties, distinguished by differences in form, squamation, and development of

[1] According to information communicated to A. Günther (1889) both *H. nobilis* and *H. molitrix* attain equal size, "exceeding a length of four feet."

fins." The Carassius, in the form of the goldfish, is common everywhere; "in its native condition the species is plain dark olivaceous," but domesticated varieties and monstrosities are innumerable. The Gobionines number eight species of five genera; *Gobio,* the Gudgeon genus, though not represented immediately, is represented mediately by several genera (especially by one, *Leucogobio,* with four species, and another, *Abbotina,* with one) differing from each other as well as from *Gobio* by slight differences of the mouth and lips. The Leuciscines are no less than sixteen; *Leuciscus,* the chub genus, has six congeneric relations, and *Phoxinus,* the minnow, one. A characteristic species is that here figured, *Leuciscus phalacrocorax,* whose rather strange name was given because some specimens obtained by Jordan and Fowler were caught by trained cormorants of the genus *Phalacrocorax* in the Tana river. To the Rhodeine subfamily have been referred seven species of four genera, but it is not known whether any exercises the peculiar mode of oviposition

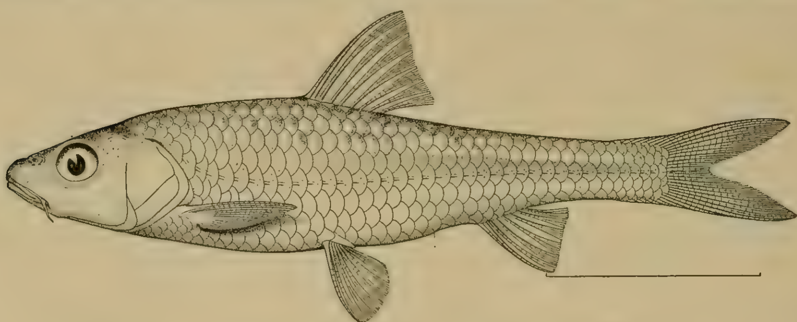

FIG. 87.—*Leucogobio mayedæ.* After Jordan and Fowler.

within the valves of a Unionid as does the bitterling of Germany. It is noteworthy, however, that one of the species, *Pseudoperilampus typus,* has been given a Japanese name (Nigabuna) which conveys the same allusion (bitter carp) as the German name; it rarely attains a length of three inches. Several of the Rhodeines are remarkable for traits of color. Few of the Cyprinids have distinct black markings, the predominant colors being brownish or olivaceous on the back and sides and whitish or silvery below, and consequently the European Leuciscines are collectively designated as whitefish and this has been rendered into the Greek derivative *Leuciscus.* Among the exceptions to the rule are Rhodeines, one of which (*Acheilognathus cyanostigma*) is here illustrated; a black lateral band concurrent with the dorsal outlines is very conspicuous. It is one of the many fishes of the great Japanese lake Biwa. The

FIG. 88.—*Abbottina psegma.* After Jordan and Fowler.

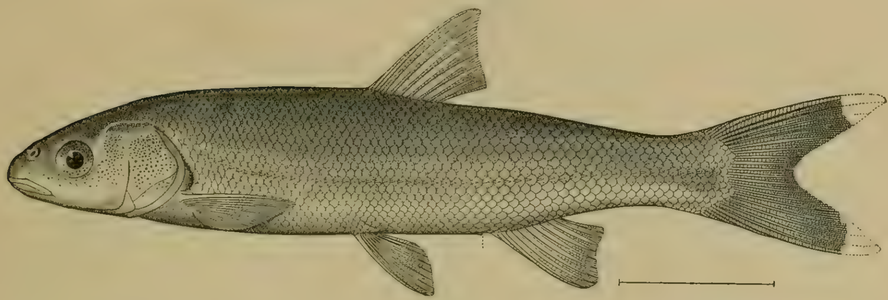

FIG. 89.—*Leuciscus phalacrocorax.* After Jordan and Fowler.

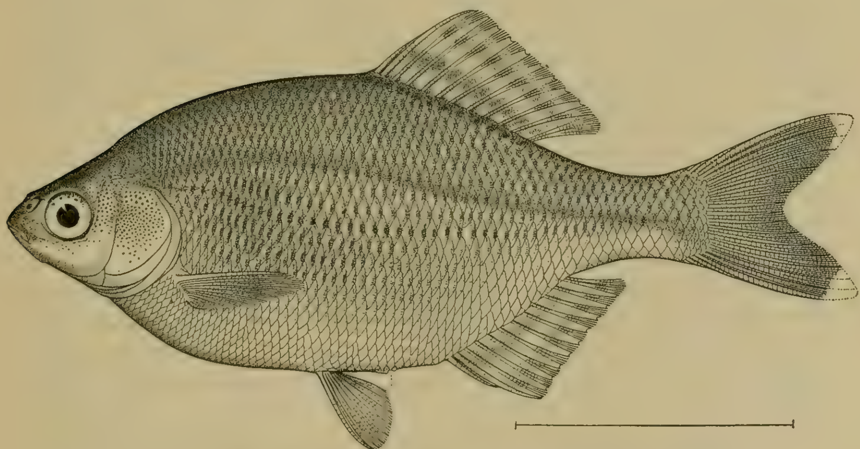

FIG. 90.—*Pseudoperilampus typus.* After Jordan and Fowler.

Barbel (Barbine) group has a single representative, *Barbus schlegeli* or *Hemibarbus barbus,* which grows to about ten inches in length.

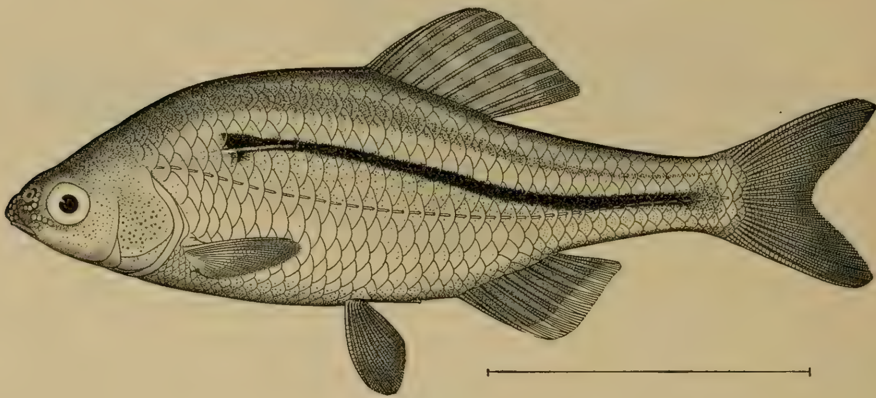

FIG. 91.—*Acheilognathus cyanostigma.* After Jordan and Fowler.

SOUTHERN ASIATIC CYPRINIDS

Asia, south of the Himalayas, the continent east of India, and the great as well as small islands of the Indo-Moluccan archipelago, as well as the Philippine islands, support a very numerous cyprinoid population amounting to some 500 or 600 species. The best known of the regions into which the realm is divided are India and the Dutch islands, the former of which has been most fully illustrated by F. Day and the latter by P. von Bleeker. Day (1889) recognized 185 species belonging to the Indian fauna and Bleeker (1864) 119 species representing the "Indo-Archipelagic" area. The species of Indo-China (Tongking, Annan, Siam, Cochin China, Cambodia and Siam) were given as 57 by Sauvage in 1881. To these many have been added since from all the regions.

India is a favored land of Cyprinids and some of them are fine game fishes. Far above all is the "kingly Mahseer" (*Barbus tor*); but high in the second rank come "the grand Rohu" (*Labeo rohita*), "the sprightly Mirgha" (*Cirrhina mrigala*), and "the massive Catla" (*Catla catla* or *buchanani*), as they are styled by Thomas in "The Rod in India" (1897, p. 196). Smaller species, but at least equally game, are the wide-mouthed Barils which have some superficial resemblance to, and by most English residents are called trout.

The most conspicuous or the most characteristic of the species alone can be now briefly noticed.

The dominant genus of India is that of the barbels (*Barbus*), containing, as it does, according to the views of Day and most recent authors, about a third of its cyprinoid fauna, or seventy species. Only one of them demands consideration here.

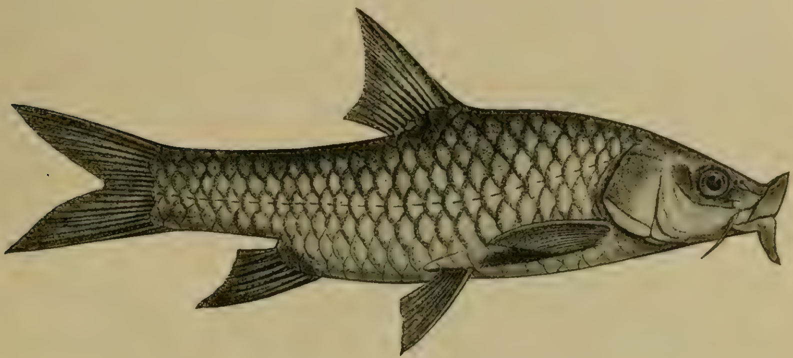

FIG. 92.—*Barbus tor* or *mosal*. After Day.

The Mahseer or Mahsir (*Barbus tor* or *mosal*) is the chief of a small file of species confined to Southern Asia and recognizable by the strong smooth dorsal spine, seven or eight branched anal rays, and the very large scales. The Mahseer itself has twenty-five to twenty-seven scales along the lateral line, two and a half scales between the lateral line and ventral fin, a pointed snout, fleshy lobate lips, and a dorsal spine as long as the head back of the snout. It is the principal fresh-water game fish of India, in which country it is almost everywhere found but, according to Day, it occurs in the "greatest abundance in mountain streams or those which are rocky." It occasionally reaches a very large size, and G. P. Sanderson, the author of "Thirteen years among the wild beasts of India," in a letter published by Thomas, affirmed that he had "no doubt in" his "own mind that they run over 200 or 250 pounds," as he had seen teeth and bones of them far larger than he claimed to have caught; he added that "they are often caught by the natives." The more modest maximum of a hundred pounds is admitted by others. These figures, however, refer to entirely exceptional individuals. An experienced angler quoted in Thomas's work (p. 406) wrote that "in northern India they do not run to any greater size in the rivers of Jhansi and Lullutpore than twelve to fifteen pounds." He thought that "instances of fish caught over ten pounds are rare." Size, however, "depends much on the size of the river in which the mahseer is found.'"

The mahseer is a carnivorous fish, preying chiefly on smaller representatives of its class. It is angled for with live bait, with the spoon, with flies, with paste, and with parched grain. Instructions for all kinds are given by Thomas in "The Rod in India" in nine chapters and 140 pages devoted especially to the species.

The palatability of the mahseer is a matter respecting which there is some difference of opinion. According to Thomas (p. 23), much depends on the size and condition of the fish. He had "tasted mahseer in such high condition that they were excellent; they were so rich that one could not eat any melted butter or other sauce with them, and so well flavoured that they seemed" to him "to stand between the salmon and the trout for the table." He considered that "the best size for flavour" is about six or seven pounds, or between limits of two and ten pounds. "When less than two pounds they are too bony; when much larger than ten pounds they are apt to be too gross and oily for European tastes, but they are always thought thoroughly edible by your camp."

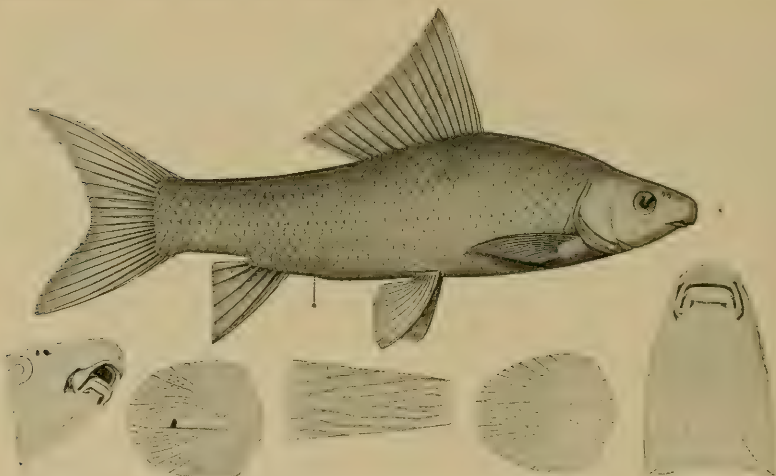

FIG. 93.—*Labeo vulgaris.* After Heckel.

The Indian genus next in importance to *Barbus,* so far as number of species is concerned, is *Labeo.* This essentially agrees with *Barbus* in form and has, like it, three rows of pharyngeal teeth, but the lips are peculiar in that the lateral folds are enlarged and each lip has an internal cross-fold covered by a trenchant corneous but soft and deciduous covering; the snout is smaller, the suborbitals are narrow, and the dorsal is rather long, having twelve to sixteen rays.

Twenty-five Indian species have been referred by Day to this genus, including species with and without barbels, but have been separated by others (especially Bleeker) in several genera. A number of the species attain a large size and some are quite highly esteemed for the table, at least by natives of India.

The largest species, *Labeo gonius,* the goni of Bengal, sometimes reaches a length of five feet and about seventy pounds. Several attain a length of at least three feet, such as the *Labeo calbasu* (Kalbasu of Bengal or kalbans), the *Labeo nandina* (Nandin of Bengal), the *Labeo rohita* or Rohu, and the *Labeo dyochilus* (Boallo of Hindustan). Others range down from two feet to a few inches in length.

FIG. 94.—*Labeo calbasu.* After Day.

The best known of these, at least from an angler's point of view, is the Rohu. A chapter has been devoted to that species (and incidentally others) by Thomas in "The Rod in India." He asserts (p. 193) that he "never knew any fisherman, however good at mahseer, who had once tried this labeo fishing" with him, who "was not fully converted to it as taxing all his skill in a higher degree than any other fishing, and as showing sport of a superior order."

According to Day, the Rohu "is esteemed excellent as food, propagated with care in ponds in Bengal."

One of the largest of the Indian fishes is known as the catla in Bengal, and scientifically as the *Catla catla* or *buchanani.* It has a carp-like form, but the large head is much more arched between the eyes and backward there are no barbels. The rami of the lower jaw are loosely connected and the dorsal fin is shorter. But the most distinctive characters have to be sought for deeper. The pharyngeal teeth are in three rows, but none are molariform, and the gill-rakers

are especially notable, being setiform and close together, somewhat as in a shad.

The catla, according to Day, " attains at least six feet in length and a weight of 100 pounds; it resides in fresh or brackish water, being found within tidal influence." It ranges throughout India to the Kistna, and eastward through Bengal and Burma to Siam.

FIG. 95.—*Catla buchanani.* After Day.

Hamilton Buchanan found that " it is a very strong active animal, and often leaps over the seine of the fishermen, on which account, when fishing for the catla, they usually follow the net in canoes and make a noise by shouting and splashing with their paddles." It is said by Thomas to be " very destructive to small fish."

As one of the regular game fishes of India, it is claimed by H. S. Thomas that " one must fish with the bait off the ground, for his mouth would seem to be formed to take bait from above and not off the ground." As bait, " small fish, spoon and phantom " are used to some extent, but " paste is the standard bait."

The " sprightly mirgha " (*Cirrhina mrigala*) is the chief of a genus (*Cirrhina*) generally approximated to catla, but with short gill-rakers, a smaller head with little arched interorbital area, and the lower jaw with a symphysial tubercle. Five Indian and other southeastern Asiatic species have been recognized.

The mirgha, according to Day, is an inhabitant of " rivers and tanks in Bengal, Deccan, Northwest Provinces, Punjab, Sind, Cutch and Burma," and grows to a length of three feet and a weight of some forty pounds. It is considered to be " an excellent species for stocking tanks with," and is also an esteemed angle fish. Thomas records that fishes are " taken with a rod up to 34 pounds in weight."

FIG. 96—*Cirrhina mrigala.* After Day.

Another group, designated as the Danionines, has been distinguished because the species differ from all the preceding by the course of the lateral line along the caudal peduncle considerably below its middle instead of along the middle as in most fishes; the anal fin is moderately long, having at least eleven or more branched rays. The fishes are mostly small, but some of one genus (*Barilius*) are noteworthy. They have a fusiform or trout-like form, mouth deeply cleft (the jaws extending backwards under the eyes), and broad sub-orbitals. Fourteen species are recognized by Day as Indian and of these one (*Barilius bola*) is noteworthy as the "Indian

FIG. 97.—*Barilius bola.* After Day.

trout." The misapplication of the name is less glaring than many of the misnomers to be met, for the fish has an outline, mouth, arrangement of fins, and spots not very unlike those of a trout. Of course the likeness is entirely superficial and a little attention reveals the fact that differences innumerable exist. Even the color is quite unlike that of any trout, the spots being rather large, bluish, and in two or more rows.

The bola, according to Day, is a native of "Orissa, Bengal, Northwest Provinces, Assam, and Burma," where it is most at home in "clear streams with stony bed." Its average weight is about three-quarters of a pound, and the maximum near five pounds. Fishes are "taken with the fly, and likewise with small spinning bait; a small phantom is very good bait to use." A hooked fish "will

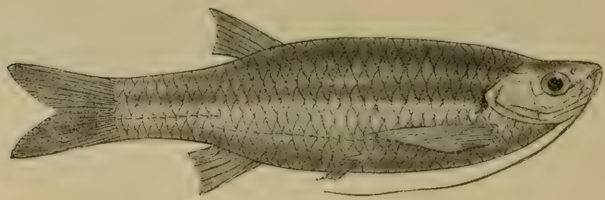

FIG. 98.—*Nuria danrica.* After Day.

jump repeatedly out of the water and dash about in a perfect frenzy and is game to the last."

Another remarkable oriental type is the genus *Nuria,* also a representative of the group *Danioninæ* distinguished by the inferior position behind of the lateral line which runs nearer the lower edge; the dorsal is also farther back and little in advance of the anal. *Nuria* is further distinguished, not only from the other species of Danionines, but from all other Cyprinids, by the very long maxillary barbels which are quite as prolonged as those of an ordinary catfish. The *Nuria danrica* is a fish which "attains five inches in length" and

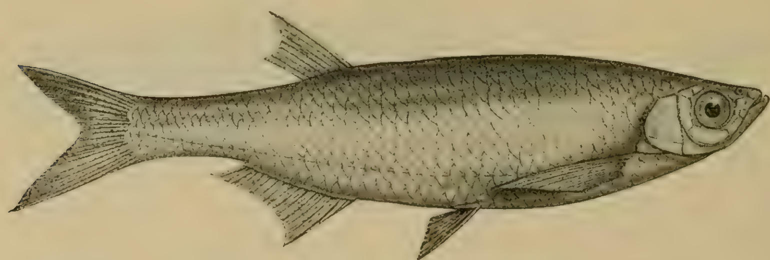

FIG. 99.—*Chela argentea.* After Day.

occurs in India as well as Burma, Ceylon and the Nicobars. It was also found "in a hot stream of 112° Fahr. at Pooree" and likewise "in a hot stream at Cannia in Ceylon."

Another characteristic Indian genus is *Chela,* whose name is latinized from the Hindustanee name *Chilwa,* applied to the principal species. The group is closely related to *Pelecus,* whose type is the

sichling of Germany (*P. cultratus*); indeed, it differs by little more than the course of the lateral line which is moderately and regularly decurved and continuous, while in the sichling it is abruptly deflected behind the base of the pectoral and thence irregularly continuous and parallel with the belly and anal to the caudal. Ten Indian fishes are referred to the genus, all being of small size, relatively to the large fishes already noticed, that is, nine inches or less. The most important of the species is the *Chela argentea*, distinguishable from its fellows by the combination of a moderately long anal fin (with seventeen to nineteen rays) and large scales (forty-three to forty-five along lateral line). It is an inhabitant of the streams and tanks of northern India, and is in many places "a very common fish." It is, according to Thomas, "a delicate fish both to eat and to keep alive, so that it requires care to keep them alive, but, once in, they will live in any pond, and keep its surface alive with rises. They thrive in any still water. In the river they are to be found in the still water." The Chelas generally "are most game fly-takers, springing into the air after the fly. They want striking very quickly, and especially they want the smallest possible fly." Detailed instructions for fishing are given by Thomas.

African Cyprinids

The Cyprinids of tropical and southern Africa are of the same general type as those of India and the prominent genera of the latter region are also the chief ones of Africa. Thus, *Barbus* is represented by one hundred and thirty-three species, *Labeo* by thirty-two, and *Barilius* by sixteen, consequently by more than in India itself, but by many less than in the Indian realm, which also includes Further India and the Indo-Moluccan archipelago. The figures here given are those presented by Boulenger in "A List of the Freshwater Fishes of Africa" (July, 1905). In this list just two hundred species of Cyprinids (including one Cobitid) are attributed to Africa and, with the exception of a *Phoxinellus* and an *Alburnus*, are of or related to warm Asiatic types. Other species, especially of barbels, have been added since.

The genus *Barbus* as here accepted is a *polymorphous* group which will doubtless be ultimately subdivided into various genera and would be now if the classification was brought into harmony with American usage as well as that generally applied to the European species. A prominent African type is that represented by a celebrated species, the bynni of modern Egyptians.

The bynni, or benny, of the Nile (*Barbus bynni*) is the type of a group represented by about fifty species in Africa, having a very strong, smooth dorsal spine, five branched anal rays, and large scales (there are barely three scales between the lateral line and the ventral fin) ; the snout is very protuberant, and the anterior barbels about as long as the eye.

The bynni was, in the time of the Ptolomies, named *Lepidotus*

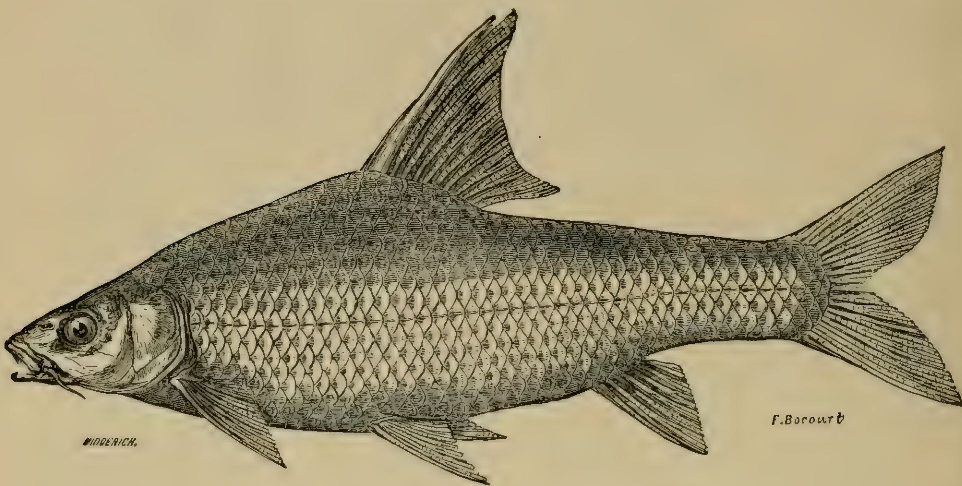

FIG. 100.—*Barbus bynni*. After Geoffroy Saint-Hilaire.

by the Greeks, or at least it has been supposed by E. Geoffroy Saint-Hilaire and others to be the fish so called by Greek writers, especially Strabo and Athenæus ; it was the object of veneration of the dwellers along the Nile, and shared this attention with the oxyrhynchus, a mormyroid fish. It is now highly esteemed for its flesh and there is a very ambiguous "proverb" which is intended to express that esteem : "If thou knowest any better than me, do not eat me." It is the special object of fishery at various places, especially Syout and Kené. Commonly it is eighteen or twenty inches long, but not infrequently attains a length of forty inches or even more. It was especially recommended for introduction and acclimation in France by I. Geoffroy Saint-Hilaire.

To give some idea of the extraordinary extent given to the genus *Barbus* by one of the ablest of European ichthyologists another species referred to that genus may be illustrated. It is a large, fine fish of Central Africa and has been named by Dr. Boulenger *Barbus tropidolepis*. By some authors it would be relegated to the genus

Puntius, although not very like any of the other species. Unlike the typical barbels, it has no barbels whatever. It sometimes reaches a length of a meter (40 inches) and may attain a weight of ten or eleven kilograms. It is one of the commonest fishes of Lake Tanganyika and by the natives named M'Biriki. In the spawning season it runs up the rivers discharging into the lake and manifests as much activity as a salmon, leaping up falls five to seven feet high. It especially courses up the river Lu-Fuko, a very rapid stream interrupted by many falls, in great numbers during January to May and

FIG. 101.—*Barbus tropidolepis*. After Boulenger.

remains therein several months. It then gives employment or food to several villages nearby. Large numbers are caught in nets—sometimes as many as seventy at one time. The fish is considered to be "excellent" and, indeed, one of the very best of all the numerous fishes of Lake Tanganyika; it is not fished for, however, in the lake itself.

Three monotypic genera are peculiar to Africa—*Leptocypris, Chelæthiops* and *Neobola*—but they are closely related to Indian genera.

The genus *Chelæthiops* is of special interest on account of the very

FIG. 102.—*Chelæthiops elongatus*. After Boulenger.

backward position of the dorsal fin which is mostly over the hinder half of the anal fin—in fact as far behind as in the pikes and killie-

fishes. In most other respects the genus agrees with *Chela* and *Pelecus* as well as the Danioninæ and apparently belongs to the latter group or subfamily; like them it has the lateral line very low (" très bas ") and comparatively near the lower edge of the caudal peduncle. The only known species is the *C. elongatus* of the river Liranga, a tributary of the Congo; a native name is Pondé. It appears to attain a length of little more than two inches (" six centimetres ").

A REVIEW OF THE AMERICAN VOLUTIDÆ

By WILLIAM HEALEY DALL

In making a complete examination of the synonymy and various classifications proposed for the Volutidæ, it became evident that serious difficulties were in the way of a final revision of the whole group, on account of the obstacles to obtaining full data on many of the exotic genera, the habit of dealers in destroying with acid the characteristics of the nuclear shell, and the inaccessibility of some of the rarer species.

While the collection of Volutes belonging to the National Museum is fairly good, that portion of it relating to the American species is not only nearly complete as regards the several species, but it also contains large and unmutilated series of many of them. It was evident, therefore, that a review of the American forms was quite practicable, while a more complete revision must await fuller data and might be subject to much delay. I therefore decided to prepare the present paper.

Some sixteen years ago I was able, from a study of the recent and fossil species of our Atlantic coasts, to point out that the family was naturally divided into two great groups, in one of which the protoconch is membranous and is lost early in the intracapsular development of the young, being replaced by a shelly envelope which carries traces, when intact, of its secondary origin. In the other the protoconch is shelly from the beginning, often sculptured, and is never naturally lost except by mechanical erosion in the adult shell after it leaves its ovicapsule. These two series I distinguished as subfamilies *Volutinæ* and *Scaphellinæ* after their most characteristic genera. The latter name, however, I have since found to be inapplicable, because the real type of the genus *Scaphella* is not the species, I then supposed, but belongs to the *Volutinæ.* I now substitute for the second subfamily the name *Caricellinæ,* the genus *Caricella* of our Eocene being the ancestor of the North American series of Volutes with a membranous protoconch.

During recent years some very important data in regard to the anatomy of various species has been gathered and it is evident that while certain geographical groups of Volutes are doubtless homogeneous some of the species of which only the shell had been known are possessed of markedly distinctive characteristics.

The study of the nuclear shell had afforded valuable data; to these must now be added the general features of the anatomy; the presence or absence of a cæcum to the œsophagus; the characters of the radula; of the verge, or external male organ; and the presence or absence of an operculum. The greater or less expansion of the mantle-edge over the shell has long been known to distinguish certain groups. It is probable that, when known, the characters of the ovicapsule will prove to have a certain value. I have been able to determine the characters of the radula in a number of species where it had not been known, and its absence entirely in the genera *Aurinia* and *Maculopeplum;* I have also been able to examine the verge in a number of species and find it to exhibit features which prove to have a systematic value not less than specific, and perhaps in some cases of even greater weight. It is a little remarkable that more attention has not been paid to the details of structure in this organ.

In general, in the Volutidæ the external characters of the animal include a short rather blunt foot which, in the genera *Voluta* and *Lyria,* carries a small oblong operculum which is absent in all the other groups of which the animal is known. The nucleus of the operculum is terminal or subterminal. The head is wide, provided with short, rather stout, pointed tentacles which at their bases rise from large, rounded flaps or lappets. These lappets are sometimes continuous in front between the tentacles and sometimes separated partly or entirely by a deep median sinus. In other forms there is a sinus at the root of each tentacle with a wide, more or less auriculate lappet between the tentacles in addition to the two lateral lappets. In the *Volutomitrinæ* there are no lappets at all, the eyes being situated on the apex of a tentacular projection extending parallel with the true tentacle and soldered to it for about one-third of its length. In the case of *Tractolira* and some other abyssal forms the eyes are wholly absent, but in the great majority of Volutes they are situated on the flat surface near the anterior edge of the lateral lappets, and are not raised above that surface. The verge is situated behind the right lappet and as in many other Prosobranchs is, when at rest, bent backward under the mantle. There is usually an appendix or supplementary smaller projection near the distal end which may assume various shapes. In many species the verge is bent upon itself when at rest, forming a blunt angle like an elbow, in others the whole organ projects backward from its root; in *V. vespertilio* the whole mass of the organ projects forward and is soldered to the nuchal surface, only the appendix (which

in this case is exceptionally long) is free and recurved. In *Adelomelon* the appendix is short and hardly distinguishable from the body of the verge, being papilliform, as is also the case in *Aurinia gouldiana.* The seminal conduit in the majority of cases is an open groove which may be partly closed in some species by small interlacing papillæ situated on its outer edges. In several cases, however, it is a closed conduit, opening near the proximal end of the appendix.

The œsophageal cæcum in the majority of Volutidæ is present and conspicuous, but in a few forms it appears to be absent.

The radula in general comprises a long series of single teeth (103 were counted in *Volutomitra*) of rhachiglossate type. *Volutocorbis* and *Ternivoluta* alone are definitely known to possess also a series of single-cusped laterals on each side of the rhachidian tooth. The great majority of species of Volutes have the rhachidian tooth tricuspid with strong, nearly straight cusps; *Adelomelon ancilla* has the cusps strongly arcuate, while *A. magellanica* has flat cusps. In *Tractolira* and *Miomelon* the cusps are tusk-like. *Voluta* has the rhachidian wide with many small denticles, but *Lyria* has it tricuspid. *Scaphella Turneri* and *Volutomitra* have the base strongly arcuate and carry a single straight cusp, as does *Halia priamus.*

The ovicapsules are hemispherical, or flatter, in *Adelomelon,* except *A. brasiliana* which is believed to have a subspherical floating capsule buoyed up by an enclosed air bubble. In the other species the capsule is attached by its flat side to a stone or dead bivalve shell and contains five to ten embryos swimming in a viscid transparent fluid. Nothing is yet known of the capsule of most of the species.

The surface of the animal is often brightly colored, even in the case of forms which have dull shells like *Adelomelon,* but the abyssal species are usually colorless.

The mantle in the majority of species is not extensible over the shell but in *Zidona* of the *Caricellinæ,* and *Scaphella* (=*Amoria* Gray) of the *Volutinæ,* the entire shell is sometimes covered with enamel and destitute of a periostracum as in *Oliva.* It is probable that the same is true of *Aurinia dubia,* and many fossil groups like *Liopeplum* have heavy superficial coats of enamel thus deposited.

The proboscis is partly invertible and wholly retractile.

The subfamilies of the Volutidæ are provisionally accepted as follows:

Subfamily Volutinæ.

Shell with the protoconch shelly and persistent, the adult usually elegantly colored; animal with the eyes sessile on epipodial lappets;

siphonal lobe of the mantle with two appendicular lobes; verge large with an appendicular process; operculum usually absent; teeth of the radula usually in one tricuspid series.

Subfamily CARICELLINÆ

Shell with the protoconch membranous and caducous within the ovicapsule; operculum absent; other characters much as in *Voluta*. The radula variable, sometimes absent.

Subfamily VOLUTOMITRINÆ

Shell with protoconch minute (shelly?), the adult unicolor with a conspicuous periostracum; small, boreal. Eyes on stalks adherent to and shorter than the tentacles; no epipodial lappets, no operculum, no siphonal lobes; radula of a single long series, the separate teeth unicuspidate with deeply arcuate bases.

We may now consider the American species.

At first one would hardly think of America as a metropolis of Volutes; it is only when the scattered data are brought together, as in this paper, that it is practicable to realize that more than one third of all the known species, including *Lyria* and *Enæta*, occur on the coasts of America.

There are enumerated in the present paper thirty-three species belonging to ten genera. With the exception of one *Volutomitra* common to the north of Europe, and the species of *Voluta* which reach the coast of West Africa, all the species are strictly American, the Falkland Islands being faunally a part of South America. Of the ten genera, only *Voluta, Lyria* and *Volutomitra* are represented elsewhere than on the coast of America. A study of our Tertiary Volutidæ shows that all these groups originated in American waters, though some fossils like *Eucymba* and *Volutocorbis* are now extinct in their original region and represented in the recent fauna only by species of distant seas. The geographical grouping of genera will probably prove true for the species of other regions as it has here.

The centers of distribution were evidently two; one near the southern end of South America and the other in the Antillean region. Omitting the boreal *Volutomitra*, only four species from the former center (three of them abyssal) and three from the latter (all species of *Enæta*) have reached the Pacific coast north of south latitude 40°. All of them are well differentiated from their Atlantic ancestors. A much more profuse Volute popu-

lation as regards the number of species may be inferred from the remains in American Tertiaries, but these fossil species were nearly all of rather small size. Europe has lost still more, having only two or three species, including *Volutomitra*, remaining in her living fauna, of which none is a typical Volute.

Family VOLUTIDÆ

Subfamily Volutinæ Dall

Genus VOLUTA (Linné) Lamarck

Voluta (sp.) Linné, Syst. Nat., ed. x, p. 729, 1758; ed. xii, p. 1186, 1766.
Musica, anonymous, Mus. Calonnianum, p. 18, 1797.
Plejona Bolten, Mus. Boltenianum, p. 39, 1798.
Voluta Lamarck, Prodrome, p. 70, 1799; sole ex. *V. musica.*
Volutarius Froriep's trans. of Dumeril, Zool. Anal., p. 167, 1806.
Harpula Swainson, Zool. Ill., ii, p. 77, 1832, type *V. ebræa.*
Musica Mörch, Cat. Yoldi, p. 124, 1852.
Chlorosina Gray, in Adams, Gen. Rec. Moll., ii, p. 617. 1858, sole ex. *V. polyzonalis* Lam., = *V. virescens* Sol.
Volutolyria Crosse, Journ de Conchyl., xxv, p. 99, 1877; Fischer, Man. de Conchyl., p. 610, 1884.

Tropical and subtropical shores of the Atlantic, the Caribbean Sea and the Gulf of Mexico, at the present day; fossil, from the Eocene upward, in the Tertiaries of France, the Mediterranean and the Antillean region.

The first representatives of this group occur in the Eocene and resemble more closely the recent *Lyria* than the fully evolved *Voluta*. These two genera are separated on anatomical characters which are inaccessible in the fossils, the shell characters alone being insufficient to separate the groups more than subgenerically.

The Antillean region seems to have been their center of dispersion. The inter-island distribution of the various forms is very imperfectly known but it is likely that the three species enumerated, if not all their varieties, occur over a certain portion of the West African coast as well as on the American shores. The elevation in the later Oligocene of the Central American connection between the continents of North and South America seems to have barred the later developed forms of typical *Voluta* from reaching the Pacific, where only a few small species, of the *Lyria* type, are known to exist.

The type of the genus is *Voluta musica* Linné.

VOLUTA MUSICA Linné

Voluta musica LINNÉ, Syst. Nat., ed. x, p. 733, No. 370, 1758; Lamarck, Prodr. Nouv. Class. Coq., p. 70, 1799; Sowerby Thes. Conch., Mon. *Voluta,* p. 211, pl. XLIX, figs. 36–43, 1847; Reeve, Conch. Icon., VI, *Voluta,* pl. VIII, figs. 18*a*–18*d*, pl. IX, fig. 18*e*, 1849.

The Music Shell of the older authors was first given a binomial name by Linné in 1758, and his references to figures include both the variety afterward named by Lamarck *carneolata,* and that which is regarded as the typical variety in the present paper. The species, in a wide sense, is common to both sides of the tropical Atlantic, but little or no attention seems to have been paid to the geographical distribution of the several varieties. The collection of the National Museum is well supplied with specimens of the American varieties, but in many cases the donor has remained satisfied with giving "West Indies" as the habitat. Linné mentioned Jamaica and Barbados as the localities for the species. A search in the literature of the subject shows as habitats for *V. musica,* without specifying the variety, Cuba, Guadaloupe, Santa Lucia, Isles de Saintes, Jamaica, Barbados, and Margarita Island, off the coast of Venezuela, where Krebs states the largest known specimens were obtained. There is no doubt that certain forms of the species, as of *V. hebræa,* occur on the west coast of Africa.

We may now consider the varieties separately.

Voluta musica typica LAMARCK.

BONNANI, Recreatio Ment. et Ocul., II, p. 155, fig. 297, 1684 (cited by Linné); Lamarck, Ann. du Museum, XVII, p. 66, 1811; Encyl. Méth., pl. 380, fig. 1, 1780; Sowerby, Thes. Conchyl., p. 211, pl. XLIX, fig. 40, 1847.

Tobago, West Indies (Rawson).

Shell short, wide, buff or yellowish white under the usual brownish tracery, with six or seven subspinose stout ribs at the shoulder of the whorl; nucleus dark brown; sparse spiral sculpture near the canal only; interior of the aperture usually white; outer lip with black spots, pillar lip with nine to eleven plaits.

U. S. Nat. Mus., 54,517 and 54,522.

Lamarck names a violet tinted race of this form, variety *violacea.* This I have not seen. A specimen marked "West Indies," collected by Wright, may have been obtained in Cuba, where he gathered plants.

Voluta musica carneolata LAMARCK.

LAMARCK, Ann. du Mus., XVII, p. 67, 1811; Encycl. Méth., pl. 379, fig. 4, 1780; Sowerby, Thes. Conchyl., p. 219, pl. XLIX, fig. 37, 1847.

Barbados (Rawson); Liberia (Osborne); Porto Rico (Gundlach).

Shell oval, with prevalent red tracery over a flesh-colored ground, smaller than the variety *thiarella* Lamarck, and narrower than the typical *musica;* nucleus orange-yellow; with eight to eleven low ribs, feebly nodose at the shoulder; middle of the whorl smooth, but with spiral cords or flat ridges in front of the suture and near the canal; aperture orange-pink with brown spots on the outer lip and nine to eleven plaits on the pillar lip.

U. S. Nat. Mus., 2937, 54,516, 54,520, 118,050, 123,452, and 129,246.

An unfigured, transversely wrinkled specimen was named variety *rugifera* by Lamarck. It was perhaps pathological.

Voluta musica lævigata LAMARCK.

LAMARCK, Ann. du Mus., XVII, p. 67, 1811; Encyl. Méth., pl. 379, fig. *2a–b,* 1780; Sowerby, Thes. Conchyl., p. 219, pl. XLIX, fig. 36, 1847.

La Guayra, Venezuela (Bartleman), common; "West Indies" (B. H. Wright).

Shell oval, with seven to nine low, hardly nodulous, ribs; nucleus brown; yellowish with crowded dark zigzag blotches, the parallel brown lines tending to become obsolete; spiral sculpture faint or absent in front of the suture and normal near the canal; aperture yellowish pink; outer lip with brown spots which sometimes project as nodules, the pillar lip with eight to thirteen plaits.

U. S. Nat. Mus., 75,268, 122,218.

This, from the intensity of its dark blotches, is a very well marked and easily recognized form.

Voluta musica damula DALL, nov.

SOWERBY, Thes. Conchyl., pl. XLIX, fig. 42, 1847; Curaçao (Rawson).

Shell small, oval, with eight or nine low ribs, slightly nodulous at the shoulder; nucleus pale brown; ground color whitish, with the usual tracery in fawn-color and pale brown, with vertical brown fringe-like lines and distinct spiral sculpture in front of the suture and four or five flattish ridges on the canal; aperture livid pink, or sometimes violaceous, with brown spots on the outer lip and nine or ten plaits on the pillar lip; a specimen of four whorls, beside the nucleus, measures 42 mm. long and 21 mm. wide.

U. S. Nat. Mus., 54,521 and 29,249.

This is easily distinguished by its pale coloration and small size.

Voluta musica plicata DILLWYN.

Voluta sulcata LAMARCK, Ann. du Mus., XVII, p. 68, 1811; Chemnitz, Conch. Cab., X, p. 151, pl. 149, figs. 1403-4, 1788; Sowerby, Thes. Conchyl., p. 212, pl. LIII, fig. 87, 1847. Not *V. sulcata* Gmelin, 1792.
Voluta plicata DILLWYN, Descr. Cat. Rec. Shells, I, p. 563, No. 152, 1817.

"West Indies" (Chamberlain).

Shell oval, of much the same form as variety *carneolata*, with eight or nine low inconspicuous ribs, not nodulous at the suture, white, with nebulous fawn-colored blotches and the spiral brown lines obsolete; three narrow white spiral bands articulated sparsely with dark brown, and numerous fine brown dots on the body; whole surface spirally sulcate, the interspaces having the aspect of flattish slightly elevated bands; nucleus yellowish white; aperture whitish or yellow, with brown spots on the outer lip and ten or eleven plaits on the pillar lip.

U. S. Nat. Mus., 131,232.

A well marked variety, but hardly to be considered as a species.

Voluta musica polypleura CROSSE.

CROSSE, Journ. de Conchyl., XXIV, p. 163, pl. V, fig. 6, 1876.

Antilles?, Crosse (Coll. Prévost).

This differs from the other varieties of the species in the total absence of the brown lines which mimic a musical manuscript; by strong spiral sulcations near the canal and in front of the suture but absent from the body of the shell; and by numerous longitudinal riblets in the interspaces between the usual ribs. The nucleus is horn-color; there are eleven plaits on the pillar lip, of which three are feeble; the aperture is whitish and the shell measures 56 mm. in length, with a greatest diameter of 30 mm.

This form is only known from the specimens which served Crosse for his description and of which the provenance is unknown, but which may have come from the Antilles. It is possibly referable to the *V. chlorosina* of Lamarck.

There are several other varieties which have not, so far, been reported from the West Indian region. These are the *Voluta thiarella* Lamarck, based on the *Voluta musica elongata* of Chemnitz, which has the spire abnormally produced, and to a color variety of which Lamarck gave the name of *Voluta nebulosa*. Another is the *Voluta guiniaca* of Lamarck, founded on a shell brought from Guinea and given by a friend to Chemnitz (Conch. Cab. XI, pl. 178, figs. 1717-18; 1795), who called it *Voluta musica guineënsis*.

VOLUTA VIRESCENS Solander

Voluta virescens SOLANDER, Portland Cat., p. 26, No. 610, 1786; after Martini, Conch. Cab., III, p. 243, pl. 97, figs. 932–3, 1777; Dall, Bull. Mus. Comp. Zool., XVIII, p. 146, 1899.
Voluta polyzonalis LAMARCK, Ann. du Mus., XVII, p. 68, No. 27, 1811; Encycl. Méth., II, pl. 379, fig. 1*a–b*.
Muriciformes cantinclosus MEUSCHEN, Mus. Gevers., p. 326, 1787.
Voluta fulva LAMARCK, Ann. du Mus., XVII, p. 68, No. 28, 1811; Encycl. Méth., II, pl. 382, fig. 3*a–b* (bleached specimen).
? *Voluta pusio* SWAINSON, Zool. Ill., II, pl. 181, 1831; Sowerby, Thes. Conch., I, p. 213, No. 47, pl. 55, fig. 119, 1847.

From Mesquital, Texas, south to Nicaragua (Fluck), to Sabanilla and Carthagena, New Grenada (Schott), West Africa (Ward), Guinea coast, etc.

This species, contrary to my former suspicions, really does occur in West Africa, and probably along the whole northern coast of South America, as well as the eastern coast of Central America, Mexico, and northward to the Gulf coast of Texas. It is a well defined species, showing little variation among the specimens I have seen. The young shell is strongly spirally sulcate, a character gradually lost with growth.

Swainson's *pusio* is, if a variety, as claimed by various writers, much wider and shorter than the typical form, though Swainson's type was evidently a bleached shell.

The *V. fulva* of Lamarck, from his figures, should be referred to this species, being probably a bleached shell. I cannot, however, agree with the opinion of Dillwyn who refers *V. guinaica* Lamarck to the synonymy of this species.

U. S. Nat. Mus., 3033, 6141, 149,756, 149,757, 186,296.

VOLUTA EBRÆA Linné

Voluta ebræa LINNÉ, Syst. Nat., ed. X, p. 733, No. 372, 1758; ed. XII, p. 1194; Hanley, Conch. Lin., p. 233.
Voluta hebræa GMELIN, Syst. Nat., VI, p. 3461, 1792; Lamarck, Ann. du Museum, XVII, p. 65, No. 20, 1811; Sowerby, Thes. Conchyl., I, p. 211, No. 43, pl. LIV, figs. 95–6, 1847.
Buccinum coronatum MARTYN, Univ. Conch., II, pl. 83, 1786.
Voluta turbinata KIENER, Icon., *Voluta*, p. 19, pl. XXVI, fig. 2, 1839.

Jamaica (Martini); Pernambuco et Maceio, Brazil, common (Greeley); West Africa (Carpenter, Rich, McGuire, Stearns); Madagascar (Humphrey).

This well known shell is rather common for one of this genus. Most of the specimens in the National Museum are African. It was found by Branner's party, common along the shore near Per-

nambuco. Most of the specimens were of the normal size, but one was picked up alive with the very respectable dimensions of 150 mm. long and 90 mm. wide. The coloration, etc., agrees closely with African specimens. The *V. turbinata* of Kiener seems to be a bleached shell, thin, and without the usual brown tracery on the body. It is by most authors referred to *ebræa* as a variety or sport.

The references in the literature to *V. "vespertilio"* from the West Indies are probably based on ill-identified specimens of this species, as the *V. vespertilio* is not known from America.

U. S. Nat. Mus., 2939, 160,706, 118,043, 18,388.

Genus LYRIA Gray

Lyria GRAY, P. Z. S. Lond., 1847, p. 141; type *Voluta nucleus* Lamarck, Ann. du Mus., XVII, p. 73, 1811. Not *Liria* Gray, Phil. Mag. and Journ., 1824.

Otocheilus CONRAD, Am. Journ. Conch., I, p. 24, 1865; figured species *Fulgoraria mississippiensis* Conrad, Journ. Acad. Nat. Sci. Phila., 2d Ser., I, p. 119, pl. XIII, fig. 1, 1848.

Harpella GRAY, in Adams' Gen. Rec. Moll., II, p. 618, 1858; *V. costata* Swainson (not Solander) = *V. anna* Lesson: not *Harpella* Schrank, 1802, *Lepidoptera.*

The genus, as becomes its age, is widely distributed in tropical seas, especially in Australasia, the Indian Ocean and the Antilles. The earliest related forms, intermediate between *Plejona* and *Lyria,* are found in the Upper Cretaceous of India and the earliest Eocene of America. The nucleus is shelly and intermediate between the minute shelly nucleus of *Plejona* and the larger and blunter nucleus of *Voluta.* Like *Voluta* the animal possesses an operculum. The verge is curved and provided with a seminal groove and a terminal slender tentacular appendage. The radular teeth have few cusps, in marked distinction from those of *Voluta.*

The group, from the shell characters, may be divided into two sections, only the first of which is found in American waters.

Lyria Gray, s. s.

Shell with numerous, sometimes obsolete, ribs, a varicose outer lip smooth within, an appressed suture, and brilliant coloration. Type *Voluta nucleus* Lam.

Harpeola Dall, nov. sect.

Shell like *Lyria* s. s., but with a channelled suture and shallow posterior sulcus. Type *Voluta anna* Lesson.

LYRIA BEAUII Fischer and Bernardi

Voluta beauii F. AND B., Journ. de Conchyl., v, p. 296, pl. IX, figs. 1, 2, 1857.
Lyria beaui TRYON, Man. Conch., IV, p. 102, pl. 31, fig. 137, 1882.

Islet of Marie-Galante, near Guadaloupe, West Indies (Beau); dredged at station 2120 by the U. S. Fish Commission steamer *Albatross* in seventy-three fathoms, muddy bottom, temperature 67° Fahr., near Grenada, W. I.

U. S. Nat. Mus., 87,718.

A defective but recognizable specimen of this rare species was dredged, as above, by the *Albatross*. It remains at present the only species known of the genus from the Antilles.

Genus ENÆTA Adams

Enæta H. AND A. ADAMS, Gen. Rec. Moll., II, p. 167, 1853; first species *Voluta cumingi* BRODERIP: GRAY, Guide Moll. B. M., p. 34, 1857; sole ex. cited *Lyria harpa* BARNES, = *Voluta harpa* BARNES *non* Lamarck, = *Voluta Barnesii* GRAY.

This group appears to be entirely American in its distribution, being found on both the Atlantic and Pacific shores, but not elsewhere.

The shell is small, peculiarly solid and heavy, with an operculum like that of *Lyria*, from which it differs by the denticulation of the outer lips within the aperture when fully adult, usually exhibiting one particularly prominent denticle about the middle of the lip. *E. barnesii* has been generally accepted as type.

ENÆTA BARNESII Gray

Voluta harpa BARNES, Ann. Lyc. Nat. Hist. N. Y., I, p. 139, pl. IX, fig. 4, 1823; not *V. harpa* LAMARCK, Ann du Mus., VII, p. 74, 1811; nor of Mawe, Linn. Syst. of Conch., frontispiece, fig. 2, 1823.
Voluta barnesii GRAY, Zool. Journ., I, p. 511, note in errata, 1825; CARPENTER, Rep. Brit. As. Adv. Sci. for 1863, p. 554.

Peruvian coast and northward to Cape St. Lucas, Lower California. Localities represented in the National Museum: 4110, Cape St. Lucas; 4605, La Paz, West Mexico; 46,385, Acapulco; 46,386, Papanoa, Mexico; 133,241, San Jose, Guatemala; 15,919, Panama.

The name *Voluta harpa*, having been used several times, once by Lamarck for a Paris basin fossil, and later by Mawe for Lamarck's *Voluta* (*Lyria*) *nucleus*, should be rejected for the present species.

The most remarkable feature of the present species when in fine condition is its acute spire, but in worn specimens it is not so notice-

able. Its smooth arcuate ribbing contrasts strongly with the tubercular sculpture of the next species, but both have very similar coloration.

ENÆTA CUMINGI Broderip

Voluta Cumingi BRODERIP, P. Z. S. Lond., 1832, p. 33 (9 fathoms, Gulf of Fonseca); SOWERBY, Thes. Conch., I, p. 213, pl. 55, figs. 105, 106, 107, 1847.

Lyria (*Enæta*) *Cumingii* H. AND A. ADAMS, Gen. Rec. Moll., I, p. 167, 1853; Gray, P. Z. S. Lond., 1855, p. 62.

Magdalena Bay, west coast of Lower California, the Gulf of California, southward along the coast to San Salvador (Cuming), and Peru (Carpenter), in moderate depths of water on a muddy or sandy bottom.

U. S. Nat. Mus., 133,900, 102,598, and about ten lots from the Gulf of California.

A specimen of this species is labelled "*Lyria* (*Enæta*) *Sowerbyi* Adams," in the national collection, but I am unable to trace the origin of this name, which does not seem to appear in the literature.

ENÆTA PEDERSENII Verrill

Enæta pedersenii VERRILL, Am. Journ. Sci., n. s., XLIX, p. 226, 1870.

La Paz, Gulf of California, Pedersen.

Five specimens of this unfigured species were taken at La Paz by Capt. Pedersen. It is about an inch in length and differs from *E. cumingii* by having fine longitudinal striation over the whole surface, and at the upper whorls also transverse striation. It is also more slender.

The remaining American species, as far as known, are from the Atlantic or Caribbean coast.

ENÆTA CYLLENIFORMIS Sowerby

Voluta cylleniformis SOWERBY, Thes. Conch., I, p. 214, pl. 55, figs. 112, 113, 1847.

Lyria (*Enæta*) *cylleniformis* H. AND A. ADAMS, Gen. Rec. Moll., p. 167, 1853; GRAY, P. Z. S. Lond., 1855, p. 61.

Florida Strait, near the Bahama banks.

U. S. Nat. Mus., 107,494.

This rare species was dredged by the party under Dr. C. C. Nutting, from the University of Iowa. The specimen was destitute of the soft parts. The habitat of the species had not been previously known. It is a perfectly good species, not resembling either of the West American forms.

ENÆTA ARCHERI Angas

Voluta archeri Angas, P. Z. S. Lond., 1865, p. 55, pl. II, figs. 4, 5.
Lyria archeri Tryon, Man. Conch., IV, p. 104, pl. 31, fig. 144, 1882.

Antilles, at Montserrat and Martinique.

A rare species, which, like *E. barnesii* Gray, has much the general body sculpture of the Australasian Lyrias.

ENÆTA REEVEI Dall, nom. nov.

Voluta guttata Reeve, Conch. Icon., Mon. *Voluta*, pl. XXII, fig. 56, Dec. 1849; not of Dillwyn, 1817.
Lyria guttata Crosse, Journ. de Conchyl., XIV, p. 114, 1866.

Honduras (Dyson, two specimens).

Not reported since the original collection was made. Agrees in general character with *E. guildingi*.

ENÆTA GUILDINGII Sowerby

Voluta Guildingii Sowerby, Thes. Conchyl., I, p. 214, pl. 55, figs. 110, 111, 1847.
Lyria (*Enæta*) *Guildingi* H. and A. Adams, Gen. Rec. Moll., I, p. 167, 1853; Crosse, Journ. de Conchyl., XIV, p. 115, 1866.

St. Vincent, West Indies, Guilding.

This and the preceding species are the smallest of the group, but, unless the soft parts show some peculiarities not now known, seem to belong to this group. The *Lyria columbella* Sowerby and the *Microvoluta australis* of Angas, do not, from the figures, appear to be properly included in the family *Volutidæ*, but resemble elevated forms of the *Marginellidæ*.

Genus PLEJONA Bolten

Plejona (sp.) Bolten, Mus. Boltenianum, p. 59, 1798.
Plejona Dall, Nautilus, XIX, Apr. 1906, no. 12, p. 143; *V. spinosa* Linné (as *Conus*) selected as type.
Volutospina Bullen-Newton, Proc. Mal. Soc. Lond., VII, p. 103, June, 1906; same type.

In the Eocene and Oligocene Tertiary of the coastal plain bordering the Gulf of Mexico we find a variety of fossil Volutacea, some of which prefigure the later groups to be developed, while others appear to have left no successors in a direct line. As I have frequently pointed out, the place to find the nearest relatives of a given existing fauna is in the geological strata of the region at present occupied by that fauna, or in its vicinity, and not in distant regions. Also, it is practically certain that during the Tertiary epoch the then existing invertebrates were divided into faunæ nearly or quite as well marked as those recorded to-day.

Thus the *Volutocorbis* of South Africa has its prototypes in the Tertiaries of North America and Europe and is only distantly related to the *Volutilithes* of which it has persistently been held up as the recent representative.

The genus *Lyria* is also represented in the Eocene of the Gulf States, but not until the Pliocene do typical *Voluta* make their appearance, while I have so far not come across any fossil *Enæta* in the American Tertiary. Of the typical *Volutilithes,* represented by the European Eocene *V. muricina* Lamarck, none are known from American Tertiaries, but species conchologically related to the *V. spinosa* Lamarck, for which I some time since revived Bolten's name, *Plejona,* are well represented. We do not know any typical survivors of this group.

I shall elsewhere discuss the propriety of conserving the name *Plejona,* which I revived (by the process of elimination) in the Nautilus for April, 1906, p. 143, for the type of *Volutilithes spinosa* Lamarck. Mr. R. Bullen Newton, seeing merely the brief announcement without discussion, has objected on grounds which it would seem further consideration will show to be insufficient. He therefore has proposed for this group the name *Volutospina.* I quite agree that this would be an agreeable way to settle a disagreeable question, but unfortunately, unless we proceed by the method of elimination in this case, we shall be obliged to do worse. Bolten proposed a genus, much more homogeneous than most Linnean genera, which was properly published. Nothing authorizes us to reject this genus; the name must be applied to part of its original content and retained.

By the method of elimination we disturb no other accepted name but fix *Plejona* on a group which happily had no acceptable name. By rejecting elimination, and taking the first species, our choice must fall on either *Voluta musicalis* or *V. ebræa,* thus ousting *Voluta* as limited by Lamarck a year later than Bolten. This is exactly what Link proposed to do in May, 1807, and if his view is accepted a long list of changes would follow which are avoided by the plan I proposed in the Nautilus.

At any rate, there was nothing contrary to the rules of nomenclature in proposing to adopt one of the species of an atypical valid genus as its type, which is what I did on that occasion, so that even if I desired to change the decision, at present I have no authority under the rules to do so. In nomenclature, whatever else be waived, one must follow the rules or chaos is imminent.

It may be added that the fourth, or last figure to the right, under

number 10 on Argenville's plate, is probably *Melongena cornuta* Agassiz, since *M. melongena* is, I believe, not known as a European fossil, at least as species are understood nowadays.

Subfamily CARICELLINÆ Dall

After some uncertainty I have decided to adopt this name for the subfamily, characterized by a membranous protoconch, in contrast to the shelly protoconch of the typical volutes.

Genus ADELOMELON Dall

Adelomelon DALL, Nautilus, April, 1906, vol. XIX, no. 12, p. 143. Type *Voluta ancilla* Solander, 1786.
Scaphella, Cymbiola, etc., of authors, not of SWAINSON, 1832.

ADELOMELON ANCILLA Solander

Voluta ancilla SOLANDER, in Portland Catalogue, p. 137, no. 3061, 1786. Founded on D'Avila's "grand Buccin Magellanique," vol. I, pl. VIII, fig. S, no. 181, p. 140, 1767; *cf.* also Diderot. Encycl. Recueil des Planches, VI, pl. 67, fig. 9, 1768; Favanne, Conchyl., pl. XXVIII, fig. E, 1780; Kämmerer, Cat. Rudolstadt, pl. VII, fig. I, 1786.
Voluta magellanica CHEMNITZ, Conch. Cat., X, pp. 138–9, 1788, *ex parte,* figs. excl.
Voluta spectabilis GMELIN, Syst. Nat., VI, p. 3468, no. 142, 1792.
Voluta ancilla LAMARCK, Ann. du Mus., XVII, p. 69, 1811; Encycl. Méth., pl. 385, fig. 3, 1816; Anim. s. Vert., VII, p. 343, 1822. GOULD, Exped. Shells, Wilkes Ex. Exped., pl. XX, fig. 358, 1852.
Voluta magellanica LAHILLE, Rev. Mus. de la Plata, VI, p. 315, *ex parte* (? pl. VII, figs. 149, 154, pl. VIII, fig. 175), 1895.
Voluta (Cymbiola) ancilla CHENU, Man. Conchyl., I, p. 189, fig. 955, 1859.
Adelomelon ancilla DALL, Nautilus, XIX, no. 12, p. 143, April, 1906.

Hab. Argentine coast and south to 43° south latitude, low water to fifty fathoms, on sandy or muddy bottom.

This species was named by Solander in the Portland Catalogue, and by some of the early writers was confused with allied forms. I have cited only the figures which appear to relate to the same species as that of D'Avila, upon whose figure Solander's name rests. The name given by Chemnitz is a return to D'Avila's vernacular name; the former regarded *V. ancilla* as identical with his own *V. magellanica* in which he included what we now regard as several species. But the form figured by Chemnitz is not the same as that regarded as *magellanica* by most iconographers; neither is it the same as Solander's *ancilla*. The true *ancilla* was figured by Lamarck in the Encyclopedie and distinguished from *magellanica* by excellent figures. Since that time the only figure of *V. ancilla* which I

have been able to identify is that of Chenu in his manual, and even this is not entirely characteristic. Lahille figures no typical *ancilla*, so far as one can judge from his figures, which represent only the backs of the shells; the figures he gives which come nearest to true *ancilla* I have cited in the synonymy, but with doubt. It may be that the veritable *ancilla* does not extend to the upper Argentine coast. The specimens in the National Museum[1] agree exactly with the figures of D'Avila and Lamarck, and come from the Straits of Magellan.

There are reasons why the name *magellanica* should be placed in the synonymy of *V. ancilla*, but the fact that Chemnitz covered more that one species under the name, and figured one which was not *ancilla*, led subsequent writers in several cases to retain the name *magellanica* for the principal form erroneously united with *ancilla*. This seems to be a variable shell, but is heavier; on the whole more slender, with a longer spire, and shorter body whorl than *ancilla*. It is dangerous to put forward dogmatic opinions on such a subject without large supplies of material for comparison, but the aspect of the two forms is distinct, though they are doubtless closely related. Strebel's figures from specimens do not seem to include any which represent the typical *ancilla* of Solander, though he copies in a reduced form the figure given by D'Avila.

ADELOMELON SUBNODOSA Leach

Voluta subnodosa LEACH, Zool. Miscel., I, pl. VIII, 1814; SOWERBY, Thes. Conch., *Voluta*, p. 203, pl. XLVII, fig. 24, 1847.

Voluta ancilla SOWERBY, Thes. Conch., *Voluta*, p. 203, pl. LIV, fig. 101, 1847 (not *V. ancilla* SOL. or LAM.); Hanley's Wood's Ind. Test., Suppl., p. 209, pl. III, Voluta, fig. 1, 1856; KIENER, Icon. Coq. Viv., *Voluta*, p. 39, pl. 52, 1839.

Voluta magellanica KIENER, *loc. cit.*, p. 40, according to the description.

Voluta magellanica REEVE, Conch. Icon., *Voluta*, pl. XIV, figs. 33*a*, 33*b*, 1849; not of Lamarck.

Voluta magellanica TRYON, Man. Conch., IV, p. 97, pl. XXIX, figs. 107, 108 (copied from Sowerby figs. 101 and 24), 1882.

Voluta ambigua LAHILLE, Revista Mus., La Plata, VI, p. 317 (27 of extras) pl. VIII, figs. 163–6, pl. XI, figs. 6, 9, 11; pl. XI, figs. 11–16, 1895. Not *V. ambigua* (Sol.) Sowerby, Min. Conch., IV, p. 135, pl. 399, fig. 1, 1823, or of MATON, Lin. Trans., 1807, or LAMARCK, Ann. du Mus., XVII, p. 77, 1811.

Voluta ambigua vars. *constricta, pseudotuberculata, subnodosa* and *typica*, LAHILLÉ, *l. cit.*, pp. 27–29.

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[1] Nos. 9732 and 87542.

Voluta magellanica (REEVE) STREBEL, Zool. Jahrb., XXIV, no. 2, p. 127, pl. VIII, figs. 17–24, 26–32; pl. IX, figs. 36, 41; pl. 10, figs. 53, 54, 58, 1906.

Hab. Argentine coast, near the mouth of the Rio La Plata, from low water to ten fathoms, burrowing in sandy bottom; south to Magellan Straits (Punta Arenas, etc.), and Woodcock Island, Tierra del Fuego; Falkland Islands at Port Stanley.

This species is not represented in the National Museum.

ADELOMELON BENTHALIS Dall

Scaphella benthalis DALL, Proc. U. S. N. Mus., XVIII, no. 1034, p. 13, 1895.

Gulf of Panama, at station 3360, in 1672 fathoms (3087 meters), sandy bottom; dredged by the U. S. steamer *Albatross*.

U. S. Nat. Mus., 122,998.

This species, notwithstanding the type specimen is decorticated, seems sufficiently distinct in form to be separated specifically from the southern congeners. The whorls are rounder, more nearly tabulate in front of the suture, and with a more rapidly tapering and acute spire.

ADELOMELON MARTENSI Strebel

Voluta martensi STREBEL, Zool. Jahrb., XXIV, no. 2, p. 124, pl. IX, figs. 34, 35, 42–44; pl. X, figs. 56, 56*a*, 1906.

"Peru" Coll. Godeffroy, in Hamburg Museum; Huelmo, Chile, near Puerto Montt, about south latitude 42°, near extreme low water, Coll. Dunker; Argentina, somewhat south of the estuary of Rio La Plata, 184 miles southeast of Cape Corrientes in 100 fathoms, Strebel; east-northeast of Cape Delgado (south latitude about 43°), Argentina, in 48 fathoms, sand; U. S. S. *Albatross* (young shells).

I have not seen the above species in the adult state, which, by Strebel's rather rude figures, would seem to be very similar to a well preserved somewhat thin and inflated form of *A. magellanica*. In the absence of adult specimens for comparison it would be rash to venture upon any positive expression of opinion in regard to its relations, but it may be observed that the spiral striation of the nepionic whorls is quite variable and, in the majority of specimens of *magellanica* which I have seen, these whorls have been more or less decorticated so as to appear smoother and more slender than they were originally. It is very unlikely that either species has been collected on the Peruvian coast, and the Godeffroy label was perhaps conjectural. The young specimens which agree with Strebel's figure bear the number 96,177 in the U. S. Nat. Mus.

ADELOMELON MAGELLANICA Lamarck

Voluta magellanica CHEMNITZ, Conch. Cab., x, pp. 138-9, 1788, *ex parte,* pl. 148, figs. 1383, 1384. GMELIN, Syst. Nat., VI, p. 3465, no. 110, *ex parte,* 1792.

Voluta magellanica LAMARCK, Ann. du Mus., XVII, p. 69, 1811; Encycl. Méth., pl. 385, figs. 1*a*, 1*b*, 1816; Animaux s. Vert, VII, p. 344, 1822; WOOD, Ind. Test., ed. 1, p. 101, pl. 21, fig. 168, 1825 (after Chemnitz and Lamarck).

Voluta gracilis WOOD, Ind. Test., Supple., pl. III, *Voluta,* fig. 2, 1828; ed. Hanley, p. 209, pl. III, fig. 2, 1856; (not *Voluta gracilis* SWAINSON, Journ. Sci., XVII, p. 32, Exotic Conch., pl. 43, 1821; nor of Gray, in Griffith's Cuvier, p. 601, pl. 40, fig. 4, 1834).

Voluta ancilla KIENER, Icon. Coq. Viv., *Voluta,* p. 39 (pl. 52 by error, really pl. 51), 1839; not *V. ancilla* Lam.

Voluta magellanica GOULD, Expedition Shells, Wilkes' Exped., p. 278, pl. XX, fig. 357, 1852 (animal fig'd).

Voluta bracata ROCHEBRUNE AND MABILLE, Miss. Cap Horn, p. 48, no. 72, 1889. Identical with the preceding.

Voluta ancilla REEVE, Conch. Icon., *Voluta,* pl. XVII, fig. 39, 1849; Tryon, Man. Conch., IV, p. 97, pl. 29, fig. 110, 1882; not of Gould, 1852.

Scaphella (*Voluta*) *arnheimi* RIVERS, Proc. Cal. Acad. Sci., 2d Ser., III, July 14, 1891.

Voluta ancilla LAHILLE, Rev. Mus. de la Plata, VI, p. 311 (21 of extras), *ex parte,* pl. I, figs. 9, 10; pl. II, figs. 62, 63; pl. VIII, figs. 159, 173 to 183, 184 to 192, 1895; also var. *typica* LAHILLE, p. 312, pl. XI, fig. 5; vars. *ponderosa, elongata* (pl. XI, fig. 2), *inflata* and (?) *expansa* LAHILLE, p. 313; and var. (?) *abbreviata* LAHILLÉ, p. 314, 1895; STREBEL, Zool. Jahrb., XXIV, no. 2, p. 92, 1906.

Voluta bracteata "Rochebrune" STREBEL, *l. c.* = *V. bracata* ROCHEBRUNE ET MABILLE.

Habitat.—From about south latitude 43° on the Argentine coast south to the Straits of Magellan, from low-water mark to 77 fathoms; usually on sandy bottom in which the animals burrow. Falkland Islands, Lively Island, York Bay and Port William. Burnt Island, Orange Harbor, on sandy bottom.

If the name *magellanica* be retained at all for a species distinct from Solander's *V. ancilla,* it must be for the more slender elongate-spired form figured by Lamarck, who first clearly discriminated between the species confused by the earlier writers. Considering how badly the synonymy is mixed up, it might be best to discard the name *magellanica* entirely. In this case Rochebrune's name of *bracata* is probably the earliest which could be used for the species. This name has been altered to *bracteata* by Strebel in his discussion of the species.

The *Scaphella Arnheimi* Rivers was described from a specimen collected by the U. S. steamer *Albatross* in the Straits of Magellan,

at station 2778, in 61 fathoms, where a very large number were obtained. This specimen fell into ignorant hands and Mr. Rivers was erroneously informed that it came from Monterey Bay, California, which was the false locality with which Mr. Arnheim received it. It was an immature shell which I examined carefully and of which I possess a good drawing, thanks to Mr. Rivers. The type was destroyed after the earthquake in San Francisco, by fire, but a cotype, exactly similar, is in the National Museum, No. 102,530.

Of the names used by Lahille for varieties of *magellanica, ponderosa* is preoccupied in *Voluta* by Dillwyn (after Solander) 1817; *elongata* by Swainson in 1821; and *inflata* by Zekeli, in 1852. From figures alone, I feel unable to express a positive opinion as to the validity of these varieties or mutations. The animal of this species is carefully figured in the atlas of the Wilkes' exploring expedition. The original specimen from which the figure was made is No. 5752 in the National collection. A specimen was dredged by the U. S. steamer *Albatross* off Bahia Blanco, Argentina, at station 2767, in 52 fathoms, sand; U. S. Nat. Mus., 87,540.

A series of some thirty-two specimens from the Straits of Magellan illustrates the species in the National Museum.

The ovicapsule, which occurred on valves of *Pecten* and other bivalves, was described by Duhaut-Cilly in 1840,[1] and has been figured by Dall, with the enclosed nepionic shell, in the Proceedings of the National Museum for 1889.[2]

ADELOMELON ORNATA (Lahille)

Voluta fusiformis ornata LAHILLE, Rev. Mus. de la Plata, VI, p. 299 (extras, p. 9), pl. IV, figs. 24, 25, 26, 1895; *not* pl. III, figs. 16, 17..

Habitat.—Coast of Argentina near the La Plata estuary. This fine species has little in common with *V. beckii* Broderip, to which it is referred by Lahille as a variety, except the zigzag vertical streaks of brownish coloration. By its large blunt nucleus, solid shell, strong spiral striation and general form, it seems amply worthy of specific distinction. According to Lahille it attains a length of 23 centimeters. There are two clean-cut plaits behind the one which forms the edge of the pillar. A specimen four and a quarter inches long has four whorls beside the large irregularly coiled nepionic nucleus. In *V. beckii* the nucleus is small, the spire subacute, the shell rather thin for its size, recalling *ancilla*, the plaits behind the edge of the pillar are ill-defined, and the central portion of the pillar

[1] Revue Zool. Soc. Cuvier., 1840, pp. 167–9.

[2] Plate IX, figs. 5, 6.

is more excavated than in *ornata*. *V. beckii* attains a larger size, according to Lahille, fourteen or fifteen inches long and over seven inches wide.

ADELOMELON BECKII Broderip

Voluta fusiformis KIENER, Icon. Coq. Viv., *Voluta*, p. 41, pl. XLIX, 1839; not of Defrance, 1829, or Brocchi, 1814, nor of SWAINSON, 1822.

Voluta festiva D'ORBIGNY, Voy. Am. Mérid., v, p. 426, 1841; not of LAMARCK, 1822.

Voluta beckii BRODERIP, P. Z. S. Lond., 1836, p. 43; *ibid.*, 1855, p. 58; SOWERBY, Thes. Conch, no. 30, p. 205, pl. LIV, fig. 104, 1847; Tryon, Man., IV, p. 97, pl. XXIX, fig. 109, 1882.

Voluta fusiformis LAHILLE, Rev. Mus. de la Plata, VI, p. 298 (extras, p. 8), pl. I, figs. 14, 15; pl. III, figs. 16 to 23; not pl. IV, 1885; also var. *connexa*, p. 300, pl. III, figs. 19, 20 (var. *ornata* excl.).

Voluta (*Cymbiola*) *becki* STREBEL, Zool. Jahrb., XXIV, heft 2, p. 97, pl. VIII, fig. 33, pl. X, fig. 55, 1906.

Habitat.—Argentine Coast, especially toward the north. Lively Island, Falkland Islands, Miss Cobb, according to Strebel. Probably not known from Magellan Straits.

Broderip's name is earlier than Kiener's, and the latter was preoccupied in *Voluta*, to begin with, so we may feel no hesitation in rejecting it in this case. The true *festiva* of Lamarck is an East African species belonging to another group.

ADELOMELON TUBERCULATA Swainson

Voluta tuberculata SWAINSON, Exotic Conch., p. 19, pl. XXIX, 1821; WOOD, Ind. Test., Suppl., *Voluta*, no. 22, 1828; KIENER, Icon., *Voluta*, p. 63, pl. XXXI, 1839; SOWERBY, Thes. Conchyl., I, p. 204, pl. I, figs. 49, 50, 1847.

Voluta (*Cymbiola*) *tuberculata* SWAINSON, Exotic Conch., ed. II, p. 19, pl. XXIX, 1841; Catlow, Conch. Nomen., p. 306, no. 56, 1845; STREBEL, Zool. Jahrb., XXIV, heft II, p. 102, pl. IX, figs. 38, 39, 47, 1906.

Voluta americana REEVE, P. Z. S. Lond., 1856, p. 2, pl. 33, figs. 1, 2; Tryon, Man. Conch., IV, p. 94, pl. 28, figs. 100, 101, 1882 (nepionic shell).

Voluta cleryana PETIT, Journ. de Conchyl., V, p. 182, pl. VI, figs. 3, 4, 1856; Crosse, *ibid.*, XIX, p. 294, 1871 (young undeveloped specimen).

Voluta tuberculata LAHILLE, as of Wood, with varieties *ferruginea*, *decipiens*, *fulgurea*, and *pseudofusiformis*, Rev. Mus. de la Plata, VI, pp. 340–42 (extras, pp. 30–32) pl. I, figs. 12, 13; pl. VII, figs. 140 to 146; pl. XII, figs. 3–6, 1895.

Southern Patagonia and northward on the Argentine coast, and, in deeper water, to Cape San Thomé, Brazil, about south latitude 22°.

The two Brazilian shells figured by Reeve and Petit are in the

nepionic stage, less than two inches long, and, from the figures, are probably referable to this species.

Specimens were collected by the U. S. Exploring Expedition under Wilkes near the mouth of the Rio Negro, Argentina, and by the U. S. steamer *Hassler* in the Straits of Magellan.

U. S. Nat. Mus., 7484 and 98,461.

This species seems nearest related to *brasiliana* and *Beckii,* but has been regarded as sufficiently distinct by several good authorities. Reeve unites it with *subnodosa* under the name of *magellanica,* but it is not the *magellanica* of Lamarck, who was the first to differentiate that species. In the absence of a connecting series I prefer to let the species stand as distinct. According to Lahille it has from three to five plaits and may reach a length of nearly six inches, with a diameter of nearly four inches. Strebel unites the variety *pseudofusiformis* Lahille with *magellanica* (Strebel), and queries if the species is not identical with *fusiformis* Kiener.

ADELOMELON BRASILIANA Solander

Voluta brasiliana SOLANDER, Portland Cat., p. 186, no. 3958, 1786.

Voluta colocynthis Brasiliana Solandri CHEMNITZ, Conch. Cab., XI, p. 10, pl. 176, figs. 1695, 1696; 1795.

Voluta colocynthis DILLWYN, Cat. Rec. Shells, I, p. 574, 1817, LAHILLE, Rev. Mus. de la Plata, VI, p. 307 (extras, p. 10, 1895; with varieties: *lactea; intermedia; globosa* (not *V. globosa* DILLWYN, Cat. Rec. Shells, p. 569, 1817); *depressa* (not *V. depressa* LAMARCK, Ann. du Mus., Paris, I, p. 479, 1802); *pseudomagellanica; carinata* (not *V. carinata* ZEKELI, 1852); *subcarinata; alternata;* and *spirabilis.*

Voluta brasiliana D'ORBIGNY, Voy. Am. Mér., V, p. 424, pl. LX, figs. 4–6, 1841; KIENER, Icon. Rec. Shells, *Voluta,* p. 31, pl. XXX, 1839; SOWERBY, Thes. Conch., p. 204, no. 28, pl. LIV, fig. 98, 1847; REEVE, Conch. Icon., *Voluta,* pl. XV, fig. 34, 1849; TRYON, Man., IV, p. 98, pl. 29, figs. 113, 115 (only), 1882.

Voluta (*Cymbiola*) *brasiliana* CROSSE, Journ. de Conchyl., XIX, p. 300, 1871; STREBEL, Zool. Jahrb., XXIV, heft 2, p. 92, 1906.

Habitat.—Shores of eastern South America from Rio Grande do Sul, Brazil, to the mouth of the La Plata and south to the Rio Negro in Patagonia. Maldonado Bay, Uruguay; young, in 10 fathoms; sand.

U. S. Nat. Mus., 185,362, 97,044, 9731 and 171,430.

This well marked species has been known for a century, but it is extremely rare to find it in good condition. The typical form reaches a length of nearly seven inches, with a width of five and one fifth inches, usually with two plaits above which may be several obscure ridges. The largest forms, which are called *globosa* by

Lahille, reach sometimes eight inches in length and five and a half in diameter. The ovicapsule of what is supposed to be this species is figured by Dall in the Proc. U. S. Nat. Museum for 1889, pl. IX, fig. 2. It floats by means of an air bubble, and is nearly spherical. The young contained in its resemble those of *A. magellanica* Lam.

ADELOMELON FERUSSACII Donovan

Voluta ferussacii DONOVAN, Nat. Repos., II, pl. LXVII, 1824; REEVE, Conch. Icon., *Voluta*, pl. X, fig. 25, 1849; SOWERBY, Thes. Conch., *Voluta*, p. 203, pl. XLVI, fig. 7, 1847.

Voluta rudis GRAY, in Griffiths' Cuvier, XIII, pl. XXX, fig. 1, 1834.

Voluta brasiliana (*pars*) TRYON, Man., IV, p. 98, pl. XXX, fig. 131 (*ferussacii*) and pl. XXIX, fig. 111 (*rudis*), 1882.

Voluta (*Aulica*) *ferussaci* CROSSE, Journ. de Conchyl., XIX, p. 286, 1871.

Voluta oviformis LAHILLE, Rev. Mus. de la Plata, VI, p. 313 (extras, p. 20), pl. II, figs. 53–56; pl. VII, figs. 121–131; pl. X, figs. 4–9, 1895; with varieties *longiuscula* and *fratercula* LAHILLE.

Voluta (*Cymbiola*) *ferussaci* STREBEL, Zool. Jahrb., XXIV, p. 100, pl. IX, figs. 46, 46*a*, 48, 49, 1906.

Habitat.—Coast of Santa Cruz, Patagonia, Ihering and Lahille; Puerto Gallegos, Strebel; eastern part of Magellan Straits, Cunningham; Punta Arenas, Mulach.

The species reaches a length of five inches by about three and a half in diameter. It has one strong anterior plait at the edge of the pillar and from two to five lesser ridges behind it; most commonly four are visible in well developed shells. It is nearest to but apparently distinct from *V. brasiliana*.

U. S. Nat. Mus., 18,389, 102,381, 171,412.

This species is described by Cunningham (Notes on Nat. Hist. of the Straits of Magellan, p. 115 *et seq.*) as burrowing in the sand at low water and occurring near the eastern entrance of the straits, and between Cape Possession and Point Dungeness, but not farther westward than S. Jago and Philipp's Bay. The soft parts of the animal are of a purplish color, more or less spotted.

Donovan's original type is described as having only two plaits. It is quite obvious from the figures given by him that the specimen, after being more or less worn by the sea, had been "cleaned" and its color revived by a liberal use of acid, which has removed a good deal of the outer layer of the shell. In this way the feeble plaits behind the large anterior one may have been obliterated.

ADELOMELON PARADOXA Lahille.

Voluta paradoxa LAHILLE, Rev. Mus. de la Plata, VI, p. 29, pl. II, fig. 68; pl. V, fig. 41; pl. VII, figs. 139, 147; pl. XII, figs. 17–21, 1895.

Habitat.—Coast of del Sur, Argentina.

Shell resembling some of the varieties of *brasiliana* and *ancilla*, with variegated zigzag brown markings on the last whorl, but in which, according to Lahille, the young shell is so different from that of any of the other species that it cannot be properly united with any other. The young shell reaches a length of two and one fifth inches, with a diameter of one and three fifths. It usually has three plaits of which the anterior is less prominent than the third. The adult measures over seven inches long and about three and a half in diameter. A shell of this size weighed 260 grams, while a specimen of *ancilla* var. *tæniolata* Lahille, of exactly the same dimensions, weighed only 154 grams.

I have not seen specimens of this species.

ADELOMELON STEARNSII Dall

Scaphella stearnsii DALL, Proc. Cal. Acad. Sci., IV, Oct., 1872, p. 270, pl. 1, fig. 1; Proc. U. S. Nat. Mus., XXIV, no. 1264, p. 517, pl. XXXV, fig. 4, Mar., 1902.

Shumagin Islands, Alaska, and westward to Captain's Bay, Unalaska, in 40 to 100 fathoms, rocky and muddy bottom; temperature of bottom water 37° to 41° Fahr. Also in Bering Sea, northward to the line of floating ice in winter, on sandy and muddy bottoms, in 61 to 350 fathoms; U. S. steamer *Albatross*.

U. S. Nat. Mus. (type), 108,993; also 91,352, 108,998, 130,513, 162,628, 162,629, etc.

The conchological characteristics of this species are so different from those of any of the South American species that one would hesitate before including it in the same group without other evidence, but an examination of its gross anatomy shows that the general characteristics of its genitalia and dentition do not differ from those of *A. magellanica*, except in minor details, and consequently the combination is allowable. Its nearest congener, *A. benthalis* Dall, inhabits the Gulf of Panama at a distance of more than 5000 sea miles; and, omitting this abyssal species, the nearest relative occurs at a distance of nearly 9000 miles. It is probable that "*Voluta*" *Lamberti* of the British Crag may be akin to our Alaskan shell.

Genus ZIDONA H. and A. Adams

Volutella D'ORBIGNY, Voy. Am. Mér., p. 422, 1841; *V. angulata* SWAINSON, sole example, not *Volutella* PERRY, 1811, nor SWAINSON, 1830.

Zidona H. AND A. ADAMS, Gen. Rec. Moll., I, p. 161, 1853; II, p. 618, 1858; FISCHER, Man. de Conchyl., p. 605, 1883; COSSMANN, Essais Pal. Comp., III, p. 104, 1899.

The remarkable extension of the mantle and modification of the form of the shell are quite sufficient to render this subdivision of

generic rank. The nuclear portion of the shell is analogous to that of *Adelomelon,* but the ovicapsule has not been described. The animal has been carefully figured by D'Orbigny.

ZIDONA ANGULATA Swainson

Voluta angulata SWAINSON, Exotic Conchology, I, pl. III and IV, 1821; SOWERBY, Thes. Conch., *Voluta,* p. 202, pl. XLVII, figs. 13, 14, 1847; REEVE, Conch. Iconica, *Voluta,* pl. XV, fig. 35, 1849.

Voluta nasica SCHUBERT AND WAGNER, Suppl. bd. Conch. Cab., XII, p. 10, pl. 217, figs. 3031, 3032, 1829.

Voluta Dufresnei DONOVAN, Nat. Repos., II, pl. 61, 1823.

Volutella angulata D'ORBIGNY, Voy. Am. Mér., V, p. 423, pl. LX, figs. 1–3, 1841; GRAY, Guide B. M., p. 35, 1857.

Voluta angulata WOOD, Index Test., Suppl., *Voluta,* no. 21, 1828; KIENER, Icon. Coq. Viv., *Voluta,* p. 65, pl. XXXVIII, 1839; TRYON, Man., IV, p. 98, pl. 29, figs. 112, 121, 1882; LAHILLE, Rev. Mus. de la Plata, VI, p. 305 (extras, p. 15), pl. I, figs. 5–8; pl. II, figs. 69–78; pl. VI, and pl. IX, 1895.

Voluta (Volutella) angulata CROSSE, Journ. de Conch., XIX, p. 301, 1871; TRYON, Struct. Syst. Conch., II, p. 164, 1883.

Zidona angulata H. AND A. ADAMS, Gen. Rec. Moll., I, p. 161, 1853; II, p. 618, 1858; FISCHER, Man. Conchyl., p. 605, 1883.

Habitat.—South American southeast coast from Rio Grande do Sul, Brazil, south to the Bay of San Blas, Patagonia; on sandy bottom, in comparatively shallow water.

U. S. Nat. Mus. 125,492.

Lahille has described varieties *luteola, mixta* (not *V. mixta* Galeotti, 1837), *similis, distincta, ventricosa* (not *V. ventricosa* Dillwyn, 1817), and *affinis* (not *V. affinis* of Brocchi, 1814). The shell reaches to a diameter of five and a length of over seven inches. The apical spur of callus, found only in well developed specimens and frequently broken off, may attain over an inch in length beyond the apex of the spire.

Recent explorations in Patagonian Tertiaries by Hatcher of the Princeton University Expedition, have been discussed by Ortmann, who has shown that the fossil species of that and the Chilean Tertiary have the nuclear characters of *Adelomelon* although there is a small group of species including one recent form, which from their sculpture I had previously suspected to be related to *Plejona.* These forms are the nearest relatives of the typical *Volutilithes* which have yet been discovered on the American side of the Atlantic, but are also so closely akin to *Adelomelon,* that they can perhaps only be sectionally separated from it. These forms in Tertiary time extended their range to the west coast of South America, where,

in the Chilean strata, they are represented by such forms as *Voluta triplicata* Sowerby, *V. gracilis* Philippi, and *V. domeykoana* Philippi. With these are *V. alta* Sowerby, which at once suggests itself as a possible ancestor for *Tractolira* and *V. obesa* Philippi, which suggests *Adelomelon*. At any rate, this group has a recent representative which is conchologically so close to the fossils that its relationship may warrantably be assumed. This is the following species, for which we may propose a section to include itself and the related fossils.

Section MIOMELON Dall, nov.

Shell with rather elevated spire, somewhat excavated in front of the suture, with more or less obvious axial ribbing and spiral striation; a delicate periostracum, the canal rather straight; the pillar with few rather slender plaits, the anterior larger; the animal has no operculum, the verge is situated just behind the right tentacle, small, clavate, with a smaller conical distal appendix; the radula has a single series of teeth, each with three subequal tusk-like cusps. Type *Volutilithes philippiana* Dall, 1889.

The type is blind, but this may be exceptional and due to its abyssal habitat. The fossil species will be *A. triplicata* Sowerby, *A. domeykoana* Philippi, and *A. gracilior* Ihering (new name for *Voluta gracilis* Philippi, 1887, not of Lea, 1833); and perhaps also *Voluta D'Orbignyana* Philippi. It is distinctly a localized group proper to the south coast of South America, both recent and fossil.

ADELOMELON (MIOMELON) PHILIPPIANA Dall

Volutilithes philippiana DALL, Proc. U. S. Nat. Mus., XII, p. 313, pl. IX, fig. 4, 1889.

Dredged by the U. S. Fish Commission steamer *Albatross* off the southwest coast of Chile, at station 2791, S. Lat. 38° 08′ and W. Lon. 75° 53′, in 677 fathoms, mud, bottom temperature 37.9° Fahr.

U. S. Nat. Mus., 97,128.

The shell is 36.5 mm. in length and but a single specimen was obtained. The nucleus was eroded so that its exact character remains in doubt.

Genus TRACTOLIRA Dall

Tractolira DALL, Proc. U. S. Nat. Mus., XVIII, no. 1034, p. 12, 1895; type *T. sparta* Dall, *l. c.*. p. 13.

The dentition of this peculiar and apparently degenerate abyssal form is marked by the same tusk-like cusps which are found in *Miomelon*, and therefore, while the erosion of the apex of the shell

makes it impossible to determine the character of the nucleus, I feel that the most probable relationship of the type is with the *Caricellinæ*. The presence in the Chilean tertiaries of what seems like a more normal relative in *Voluta alta* Sowerby is also significant.

TRACTOLIRA SPARTA Dall

Tractolira sparta DALL, Proc. U. S. Nat. Mus., XVIII, no. 1034, p. 13, 1895.

From the Gulf of Panama northward to the latitude of Acapulco, Mexico, in 1672 to 2232 fathoms.

U. S. Nat. Mus. (type), 122,999.

A fuller account of this singular and unique abyssal shell is in preparation for my report on the *Albatross* dredgings under the supervision of Dr. Alexander Agassiz.

Genus AURINIA H. and A. Adams

Voluta (sp.) BRODERIP, Zool. Journ., III, p. 81, Jan., 1827.

Fusus (sp.) SCHUBERT AND WAGNER, Conchyl. Cabinet, XII, p. 24, 1829.

Aurinia H. AND A. ADAMS, Gen. Rec. Moll., I, p. 166, 1853; Type *A.* (*Voluta*) *dubia* BRODERIP (Subgenus of *Fulgoraria*); Gray, in Adams' Gen. Rec. Moll., II, p. 617, 1858, *ex parte;* CROSSE, Journ. de Conchyl., XIX, p. 307, 1871; FISCHER, Man. de Conchyl., p. 608, Dec., 1883; *ex parte;* DALL, Trans. Wagn. Inst., III, p. 70, 1890.

Volutifusus CONRAD, Proc. Acad. Nat. Sci. Phila. for 1862, p. 563, Mar., 1863; sole ex. *Fasciolaria mutabilis* CONR., Journ. Acad. Nat. Sci., VII, p. 135, 1834; Am. Journ. Conch., II, p. 66, 1866; *V. typus* CONRAD, Miocene of North Carolina.

Livonia GRAY, *olim,* H. AND A. ADAMS, Gen. Rec. Moll., II, p. 617, 1858; not *Livona* GRAY, Guide Moll. B. M., p. 156, 1842.

This genus is the degenerate descendant in one line, as *Maculopeplum* is a normal descendant in another, from the Eocene *Caricella*. Its most prominent feature is the enfeebled plaits of the pillar, usually of diminished number as well as size, its thin shell and prominent caricella-nucleus. The absence of the radula it shares with *Maculopeplum,* though *Halia,* evidently a close relative, and even more degenerate as regards the shell, has retained the radula.

Volutifusus Conrad, founded on *V. mutabilis,* to which he afterward added *V. dubia,* is an absolute synonym of *Aurinia*.

AURINIA DUBIA Broderip

Voluta dubia BRODERIP, Zool. Journ., III, p. 81, pl. III, fig. 1, 1828; SOWERBY, Thes. Conch., I, pl. LV, fig. 115, 1847; REEVE, Conch. Icon., *Voluta,* pl. XXII, fig. 59, 1849. Not of DOHRN, Jahrb. d. Mal. Ges., VI, pp. 150–156, pl. IV, figs. 1–3, 1879, = *V. dohrni* SOWERBY.

Fusus tessellatus SCHUBERT AND WAGNER, Suppl. Bd. Mart. u. Chemn., Conch. Cab. (XII), p. 24, pl. 219, figs. 3048, 3049, 1829; KIENER, Icon. Coq. Viv., IV, *Fusus,* p. 39, pl. XXIX, fig. 1; copied in REEVE, Conch. Icon., IV, pl. XIV, fig. 53, 1847; not of Zekeli and Pictet Foss. Gosaugeb., 1852.

Voluta (*Aurinia*) *dubia* H. AND A. ADAMS, Gen. Rec. Moll., I, p. 166, 1853.

Voluta (*Volutifusus*) *dubia* CONRAD, Am. Journ. Conch., II, p. 66, 1866.

Voluta mutabilis TUOMEY AND HOLMES, Pleioc. fos. S. Car., p. 128, pl. XXVII, figs. 5, 6, 1856; not of Conrad, Journ. Acad. Nat. Sci. Phila., VII, p. 135, 1838, and Am. Journ. Sci., XLI, p. 346, pl. XI, fig. 7, 1841, Miocene of Maryland.

Voluta (*Aulica*) *dubia* TRYON, Man., IV, p. 90, pl. XXVII, figs. 77, 81, 1882.

Aurinia dubia DALL, Bull. Mus. Comp. Zool., XVIII, p. 151, 1889; Trans. Wagner Inst., III, p. 80, pl. 7, fig. 4, 1890; Bull. U. S. Nat. Mus., XXIV, no. 1264, p. 504, pl. XXIX, fig. 11, 1902.

Pliocene of South Carolina; south and west coast of Florida, and off the Florida reefs; between the mouth of the Mississippi and Cedar Kays, Florida, in 111 fathoms, gray mud; off Cape Hatteras, North Carolina, 36 to 40 miles, on sandy bottom, in 34, 124 and 168 fathoms; bottom temperature 48.5° Fahr.

U. S. Nat. Mus., 54,544, 83,866–69, 97,169.

A full description of the shell and gross anatomy will be found in the Blake Report, published by the Museum of Comparative Zoology above cited.

In January, 1827, Broderip described a shell, obtained from M. Roussell and belonging to Sowerby, under the name of *Voluta dubia.* This specimen, which he figured, has been lost sight of, but Broderip mentions that the only other known specimen was in the collection of Prince Massena. Two years later Schubert and Wagner, in the twelfth or supplemental volume of the Conchylien Cabinet, figured a shell which they called *Fusus tessellatus.* This figure is taken from a drawing. They state that they had not seen the shell and give no information as to the collection in which it is preserved, or the name of the person who furnished the sketch. The figure is bad, but not uncharacteristic; and if, as Kiener states, the Massena specimen served as type for all the authors who had treated of the species, it might be surmised that Schubert's figure was a hasty sketch made without authority from that specimen.[1] There is, at any rate, no reason to doubt that the two figures of Broderip and Schubert represent two immature specimens of the same species. Kiener gives an excellent figure, which was afterward copied in the

[1] The fact that Schubert's figure represents an immature shell and Kiener's a mature one, makes it most probable that they were derived from different sources.

Conchologia Iconica by Reeve in 1847, and the general accuracy of which, as compared with the Massena specimen, now in the Museum of Geneva, was confirmed by Kobelt in 1878, at the request of Dohrn.

Up to Kiener's time and for more than twenty years later the provenance of this species was unknown, but by the dredgings of the *Blake* several specimens were obtained in 34 to 168 fathoms off the eastern coast of the United States from North Carolina south to the Florida Keys and in the Gulf of Mexico. A young specimen, showing the nepionic shell and projecting spine, or calcarella, was figured by the writer in 1890, and the adult in 1902, from recent specimens, but Toumey and Holmes had given an excellent figure from a fossil specimen found in the Pliocene of South Carolina, under the name of *Voluta mutabilis*, in 1856. The true *V. mutabilis* is a very similar but more robust species not uncommon in the Miocene of the Carolinas.

Mr. Sowerby, in 1903, expressed the opinion that the *tessellatus* of Schubert and the *dubia* of Broderip are distinct species. This opinion is apparently based upon a supposed difference in the size of the nepionic shell. But Schubert's species is based upon an anonymous drawing which may have been taken from a specimen in which the nepionic shell had been altered by the use of acid in cleaning, as is usual with dealers' shells, and no specimen is known to exist. Moreover, in 1892, I showed[1] that while the *form* of this nepionic shell is quite constant, its actual size in different specimens differs widely. This is a well-known phenomenon in Prosobranchs, whose ovicapsules contain more than one embryo. And, in addition to that, the name *Voluta tessellata* had been used by Lamarck as early as 1811, so that it is not available for Schubert's shell. I have no doubt that Schubert's figure was intended to represent an immature specimen of the species which two years earlier had been named *dubia* by Broderip, and of which an adult was figured by Kiener. In 1871 Dr. Dohrn obtained on the west coast of Florida some specimens of a volute which he referred to *V. dubia*, and of which three excellent figures by Kobelt were published, together with his notes upon the shells. In my Blake Mollusca (p. 151, 1889) I accepted Dr. Dohrn's identification, in the absence of any specimens of his species, but pointed out characters which did not agree with those of *V. dubia*, especially the heavier shell and the presence of four plaits on the pillar instead of the obsolete two plaits in *dubia*. Up to the present month (December, 1905) I had never seen specimens of the shell figured by Dohrn. Mr. Sowerby had

[1] *Trans. Wagner Inst. Sci.*, III, p. 227.

been more fortunate, and, in 1903, he described it under the name of *Voluta Dohrni,* and gave a passable figure. Recently some collections made in 1902 by the U. S. Fish Commission steamer *Fish Hawk* were turned over to the National Museum, and among the specimens were some twenty examples of *V. Dohrni;* unfortunately, all occupied by hermit crabs and more or less dilapidated or defective. Of the distinctness of the species there is no doubt whatever, and it adds another to the remarkable group of American volutes typified by *Voluta Junonia* Hwass.

AURINIA ROBUSTA Dall

Aurinia robusta DALL, Bull. Mus. Comp. Zool., XVIII, p. 153, pl. XXXV, fig. 2, 1889; Trans. Wagner Inst., III, p. 81, pl. 7, fig. 5, 1890.

Habitat.—Straits of Florida and Gulf of Mexico, on a muddy bottom; temperature 46.1° Fahr., in 119, 242 and 280 fathoms. Also off Cozumel Island in 231 fathoms, sand, temperature 50.8° Fahr.

U. S. Nat. Mus., 54,526, 83,870 and 103,478.

A remarkable species which differs from all the others in having a chalky, easily eroded outer shell-layer, and a long, sinuous canal; the interior of the aperture being porcellanous white. It still retains the brown blotches which are the characteristic of this whole group, but they are rather feeble and inconspicuous.

AURINIA GOULDIANA Dall

Voluta gouldiana DALL, Conch. Exch., II, p. 10, July, 1887; Bull. Mus. Comp. Zool., XVIII, p. 154, pl. XXIX, fig. 3, 1889; Trans. Wagner Inst., III, p. 81, pl. 7, fig. 2, 1890.

Habitat.—From Cape Fear, North Carolina, south and west to Key West, Florida, in depths from 159 to 509 fathoms, on a sandy bottom; temperatures from 45.2° to 48.3° Fahr.

U. S. Nat. Mus., 83,827, 83,828, 83,863, 83,871–75.

This is a small species in which the brown color is either wanting, present in broad spiral stripes, or suffused over the whole surface. A fragment in which the stripes are broken up into squarish spots, at first supposed to be of this species, is now tentatively referred to *Maculopeplum dohrni.*

A full description of the shell and gross anatomy is given in the Bulletin of the Museum of Comparative Zoology, above cited. There are normally four plaits on the pillar in the young shell but these fade away until the adult shows two only and these very feeble. The

coloration of the shell fades with time; the specimens in the National Collection are much less vividly colored than when received in 1887.

Genus MACULOPEPLUM Dall

Maculopeplum DALL, Nautilus, XIX, no. 12, p. 143, April, 1906.
Scaphella (sp.) SWAINSON, Zool. Ill., 2d ser., II, no. 19, 1832. Not typical *Scaphella* SWAINSON.
Caricella (sp.) CONRAD, Journ. Acad. Nat. Sci. Phila., 2d ser., I, p. 120.
Scaphella DALL, Bull. Mus. Comp. Zool., XVIII, p. 147, 1889; Trans. Wagner Inst., III, p. 79, 1890.

This genus is closely related to *Aurinia*, and for some time I hesitated as to separating them generically. However, they represent diverging lines of descent from *Caricella* and I concluded that there was less chance for confusion in a clean-cut separation than in a subgeneric connection.

The group differs from *Aurinia* in its preservation of normal characters, such as the solid and substantial shell, and well developed columellar plaits, the anterior stronger. It agrees with that genus in starting with a membranous protoconch, which is afterward lost; in having no radula or operculum; and in its style of coloration.

The observations on the animal are based on a specimen about an inch long, of which the shell was slowly dissolved by weak acetic acid, and the soft parts thus obtained without injury to their continuity. The type is the well-known species *Voluta junonia* Hwass.

In my work on the Volutes in the Tertiary Fossils of Florida, I made no attempt to revise the nomenclature of the group upon which so many naturalists had worked, and accepted without investigation the current nomenclature except in the case of *Aurinia*. Investigation, however, has shown that this was unwise, and especially in the case of *Scaphella* Swainson. While *Voluta junonia* was included among his species of *Scaphella*, it is obvious to the careful student that it cannot be regarded as congeneric with the forms like *V. undulata*, which was the type of *Scaphella*, and which were later named *Amoria* by Gray; nor with the *Cymbiola* group, founded on *Voluta vespertilio*, which is the *Scapha* of Gray and *Aulica* of Adams and Crosse. Both of these groups have the shelly protoconch of the *Volutinæ*. A new name was therefore necessary.

MACULOPEPLUM JUNONIA Hwass

Voluta junonia HWASS, in Chemn. Conch. Cab., XI, 1795, p. 16, pl. 177, figs. 1703 1704; LAMARCK, Ann. du Museum, VII, p. 70, 1811; SWAINSON, Exotic Conch., 2d ed., p. 22, pl. XXXIII, Jan., 1835; SOWERBY, Thes. Conch., I, p. 197, pl. XLIX, fig. 44, 1847; REEVE, Conch. Icon., *Voluta*, pl. XX, fig. 50, 1849.

Voluta (Aulica) junonia CROSSE, Journ. de Conchyl., XIX, p. 285, 1871; TRYON, Man., IV, p. 90, pl. XXVI, fig. 67, 1882.

Scaphella junonia SWAINSON, Malac., p. 108, 1840; DALL, Bull. Mus. Comp. Zool., XVIII, p. 148, pl. XXXIV, figs. 5, 5*c*, 5*d*, 5*e*, 1889; Trans. Wagner Inst., III, p. 79, pl. VII, fig. 9, 1890.

Maculopeplum junonia DALL, Nautilus, XIX, no. 12, p. 143, April, 1906.

Habitat.—North Carolina southward to the northern edge of the Bahamas and Barbados, and on both coasts of the Florida peninsula, reefs and keys; seventeen miles off Cape Lookout, North Carolina, in 22 fathoms, sand, bottom temperature 78.2° Fahr.; Gulf of Mexico, in 26 fathoms, sand; off Barbados in 100 fathoms, dead (Hassler exp.); Clearwater Harbor, Florida.

U. S. Nat. Mus., 27,339 (Tarpon Springs), 53,750 (Florida Keys); 53,751; 54,540 (off Tampa Bay); 60,735; 83,864 (North Carolina); 83,865 (Nassau, N. P.); 129,236; 126,800 (Barbados); 168,847 (Sanibel Id., Florida); 187,223 (off Cape Sable, Florida).

The species is fully discussed in the Blake Report, above cited, and since that publication a small live specimen was collected on the Florida Keys. It was a female and of a light flesh color with dark reddish flecks, and subgranulose surface. There is no operculum or radula. The tentacles are short and subtriangular, each expanded at the base into a rounded disk, with the eyes just outside the root of the slender part of the tentacle. The disks do not unite in the median line, where their edges overlap a little. The siphonal appendages are short and the foot duplex at its anterior edge.

The specimens dredged by Pourtalés in the Straits of Florida seem to have belonged to the next species.

MACULOPEPLUM DOHRNI Sowerby

Voluta dubia DOHRN, Jahrb. d. Malak. Ges., VI, pp. 150–156, pl. IV, figs. 1–3, 1879; copied by TRYON, Man., IV, pl. 27, figure 77; not of Broderip.

Voluta dohrni SOWERBY, Journ. Malac., X, p. 74, pl. V, fig. 8, June, 1903.

Habitat.—Florida reefs, along the Straits of Florida (Pourtalés); Gulf stream, off Key West, at station 7282, in 109 fathoms, sand, U. S. steamer *Fish Hawk;* also at station 7279, in 98 fathoms; station 7296, in 122 fathoms; and station 2316, U. S. steamer *Albatross,* in 50 fathoms, coral, off Key West; a dead specimen.

U. S. Nat. Mus., 83,862, 187,219–22.

The pedigree of this species is discussed under the remarks on *Aurinia dubia.* All the museum specimens were dead shells occupied by hermit crabs. The large number obtained would indicate that living individuals were numerous at no great distance. The

species is considerably heavier and more solid than any of the Aurinias, is smaller and more slender than *M. junonia* and is doubtless a perfectly valid species.

Subfamily VOLUTOMITRINÆ

Genus VOLUTOMITRA Gray

Volutomitra GRAY, in Adams, Gen. Rec. Moll., I, p. 172, pl. XIX, fig. 2, 1853; type *Mitra grönlandica* Beck; II, p. 619, 1858; Guide Moll. Brit. Mus., p. 36, 1857; DALL, Bull. Mus. Comp. Zool., XVIII, p. 145, pl. XXXIV, figs. 6–7, 1889.

Mitra (Beck) MÖLLER, Index Moll. Grönl., p. 15, 1842; REEVE, Conch. Icon., *Mitra,* pl. XV, fig. 106, 1844; TRYON, Man., IV, p. 124, 1882.

This small boreal group has a single row of unicuspidate rhachidian teeth with deeply arcuate base, no operculum, no appendices to the siphon, the tentacles adjacent, not seated on disks, with the eyes one third above the base of the tentacles on prominent tubercles; the verge is subcylindrical; the shell small, unicolorous, with a conspicuous dark periostracum and plaited pillar. The nucleus is small and apparently calcareous.

VOLUTOMITRA GRONLANDICA Beck

Mitra grönlandica Beck, in Moller, Index Moll. Grönl., p. 15, 1842; REEVE, Conch. Icon., *Mitra,* pl. XV, fig. 106, 1844; TRYON, Man., IV, p. 124, pl. 36, fig. 83, 1882.

Volutomitra grönlandica H. AND A. ADAMS, Gen. Rec. Moll., I, p. 172, pl. XIX, fig. 1, 1853; GRAY, Guide, p. 36, 1857; DALL, Bull. Mus. Comp. Zool., XVIII, p. 145, pl. XXXIV, figs. 6–7, 1889; SARS, Moll. Reg. Arct. Norv., p. 244, pl. 23, fig. 12, 1878.

Habitat.—Greenland coast from Disco Bay southward in from 15 to 200 fathoms; Wellington Channel (Belcher); Iceland; Spitsbergen; Finmark, in 80–100 fathoms (Sars). Also in Pleistocene of Britain (Stimpson).

U. S. Nat. Mus., 86,974, 86,975.

The shell is about an inch in length and has been well figured by Sars, whose most southerly locality is a sea-bank off Tromso. It is not known from the eastern coast of the United States, but probably occurs on the Labrador coast.

VOLUTOMITRA ALASKANA Dall

Volutomitra alaskana DALL, Nautilus, XV, p. 103, Jan., 1902.

Habitat.—Southern and eastern parts of Bering Sea and the Aleutian Islands, in 60 to 85 fathoms, mud; and southward in the Pacific, off the American coast, following the water-isotherms of

39° Fahr., to a point off San Diego, Cala., where it was dredged by the U. S. steamer *Albatross* in 822 fathoms.

U. S. Nat. Mus., 109,001–3, 122,586, 122,600–1, 123,600.

The species is larger than the Greenland shell, and finely spirally striated all over, while, with the exception of a few coarse spirals near the canal, the Greenland species is smooth.

Note.—In the synonymy of the species enumerated in this paper, while pointing out that a number of the varietal names proposed by Lahille are preoccupied in the genus *Voluta,* I have refrained from proposing substitute names in the absence of authentically named material which would enable me to judge of the validity of the proposed varieties.

Addendum.—While this paper is passing through the press, I have received from Dr. von Ihering of the Museum of San Paulo, Brazil, a photograph and data relating to a Volute which he supposes to be new and which was obtained from the stomach of a fish in those waters off the island of St. Sebastiano. It is an *Adelomelon* of the type of *A. ornata,* but much more slender; elongate-fusiform, with two very oblique plaits and about six whorls; the spire (above the posterior commissure of the aperture) nearly half as long as the shell, which measures 220 mm., its greatest diameter about one third of the whole length. For this undescribed form Dr. von Ihering proposes the specific name of *indigesta.*

NOTES

The Hodgkins Fund

In October, 1891, Thomas George Hodgkins, Esq., of Setauket, New York, made a donation to the Smithsonian Institution, the income from a part of which was to be devoted "to the increase and diffusion of more exact knowledge in regard to the nature and properties of atmospheric air in connection with the welfare of man."

These properties may be considered in their bearing upon any or all of the sciences,—*e. g.*, not only in regard to meteorology, but in connection with hygiene, or with physics, or with any department of either biological or physical knowledge.

With the intent of furthering the donor's known wishes, the Institution has already given a number of money prizes for treatises embodying new and important discoveries in regard to the nature or properties of air. This form of encouragement will not at present be renewed.

A gold medal has been established under the name of the "Hodgkins Medal of the Smithsonian Institution," which may be awarded from time to time for important contributions to our knowledge of the nature and properties of atmospheric air, or for practical applications of our existing knowledge of them to the welfare of mankind.

Grants of money are made to specialists engaged in original investigations which involve the study of the properties of atmospheric air, accepting the phrase in its widest sense.

Among the researches now in progress under grants from the Hodgkins Fund may be mentioned: (*a*) by Professor W. P. Bradley, of Wesleyan University, to determine the relation between the initial and the final temperatures of air which in flowing through a nozzle passes from a high to a lower temperature; (*b*) by Mr. S. P. Fergusson, of Blue Hill Observatory, on the differences between the meteorological conditions on the summit of mountains and at the same height in free air; (*c*) by Professor E. L. Nichols, of Cornell University, on the properties of matter at the temperature of liquid air; and (*d*) by Mr. Alexander Larsen, of Chicago, on photographing the spectrum of lightning flashes. Professor A. Lawrence Rotch has reported that in his investigations with ballons-sondes, aided by a grant from the Hodgkins Fund, the automatic

records of barometric pressure and air temperature showed an extreme height of nearly ten miles, with a temperature of 85° F. below zero eight miles above the earth, and that at about seven miles a relatively warm stratum was entered which was found to be at a higher level in the summer and autumn.

Smithsonian Table at Naples Zoological Station

In response to a memorial signed by nearly two hundred biologists, representing about eighty universities, colleges and scientific institutions in the United States, the Smithsonian Institution has for the past twelve years supported a table at the Naples Zoological Station. During that period free use of this table has been granted to about forty specialists in various lines of biological research.

Applications for the Smithsonian seat have been numerous, and although the collective appointments for any year have but twice exceeded an occupancy of twelve months for one student, not infrequently two, and in rare instances three occupants have been accommodated at the same time through the kindness of Doctor Dohrn, the Director.

The present occupant of the Smithsonian seat at the Naples Station is Dr. Stewart Paton, of Johns Hopkins University, whose researches relate to problems of fundamental importance in connection with the structure, development, and function of the nerves, and their relation to the cardiac movements. Doctor Paton will be succeeded by Dr. M. M. Metcalf, of Oberlin College, whose researches will include a study of the early development of the nervous system in the asexual reproduction of *Salpa.*

International Fishery Congress

The International Fishery Congress will hold its fourth general meeting in the city of Washington during the summer of 1908, and to enhance the interest in its proceedings prizes for contributions of merit have been offered by a number of organizations and individuals. In view of the importance of the occasion the Smithsonian Institution has tendered an award of $200 for the best essay or treatise on " International Regulations of the Fisheries on the High Seas, their History, Objects and Results."

Valparaiso Earthquake

The Institution has been informed, through the Department of State, that an Earthquake Commission has been appointed by the

Chilean government to make a scientific investigation of the phenomena accompanying the shocks that destroyed Valparaiso, badly damaged Santiago and razed to the ground many small towns and pueblos between the capital and the coast.

The above commission is composed of the following persons:

Señor Sundt, geologist, engineer.

Señor Taulis, chief of the Meteorological Station of the Quinta Normal, the Government Experiment Station.

Señor Poenish, professor of astronomy at the University.

Señor Steffen, professor of geology at the University.

Señor Ziegler, professor of mathematics and cosmography at the University.

Señor Machado, geologist of the National Museum.

Señor Obrecht, Director of the Astronomical Observatory.

International Catalogue of Scientific Literature.

The first three annual issues of the International Catalogue have been published, together with all of the volumes of the fourth annual issue with the exception of Chemistry. In addition to these regular volumes a List of Journals was published in 1903, followed in 1904 by a Supplementary List of Journals, a total of sixty-nine volumes published since the beginning of the enterprise in 1901.

Beginning with the sixth annual issue, that is the literature of 1906, the Zoology volume will be consolidated with the Zoological Record which has for many years been published by the Zoological Society of London. This consolidation of interests was decided on at the meeting of the First International Convention of the International Catalogue held in London in 1905. The agreement with the Zoological Society of London is that the International Catalogue will collect the references to the zoological literature of the world and submit them for final classification to the specialists of the Zoological Society who have in the past prepared the Zoological Record. The International Catalogue is to bear the expense of publication. The volumes will appear with two title pages, one prepared as a continuation of the regular series of the Zoological Record, the other being the title page for the Zoology volume of the International Catalogue of Scientific Literature.

PUBLICATIONS OF THE SMITHSONIAN INSTITUTION

Continued from List of September, 1905, in Publication No. 1594

No.	*Title.*	*Series.*	*Price.*
1595	Annual Report of the Smithsonian Institution, year ending June 30, 1904[1]	R. 1904	$1.00
1596	Journal of Proceedings of the Board of Regents of the Smithsonian Institution at Meetings of December 8, 1903, and January 27 and March 7, 1904. Report of Executive Committee. Acts and Resolutions of Congress	R. 1904	.05
1597	Langley, S. P. Experiments with the Langley Aerodrome	R. 1904	.05
1598	Von Lendenfeld, R. The Relation of Wing Surface to Weight	R. 1904	.05
1599.	Hale, George E., and Ellerman, Ferdinand. The Rumford Spectroheliograph of the Yerkes Observatory	R. 1904	.05
1600	Faulhaber, C. Construction of Large Telescope Lenses	R. 1904	.05
1601	Turner, H. H. Some Reflections suggested by the Application of Photography to Astronomical Research	R. 1904	.05
1602	Poynting, J. H. Radiation in the Solar System	R. 1904	.05
1603	Wilson, C. T. R. Condensation Nuclei	R. 1904	.05
1604	Ramsay, Sir William. Present Problems of Inorganic Chemistry	R. 1904	.05
1605	Newcomb, Simon. The Evolution of the Scientific Investigator	R. 1904	.05
1606	Ditte, Alfred. Metals in the Atmosphere	R. 1904	.05
1607	Lummer, O. Observations on Vision in Brightness and in Obscurity, with a Hypothesis on the Cause of Color Blindness	R. 1904	.05
1608	Klingelfuss, Fr. A Lightning Spiral Observed Near Basel	R. 1904	.05
1609	Kahlbaum, G. W. A. Variations of Specific Gravity.	R. 1904	.05
1610	Berthier, A. Some new Methods of Lighting	R. 1904	.05
1611.	Maver, William, Jr. Progress in Wireless Telegraphy	R. 1904	.05
1612	Thomson, Elihu. Electric Welding Development	R. 1904	.05
1613	Hunt, Robert. History of Discoveries of Photography. (Revised by T. W. Smillie.)	R. 1904	.05
1614	Emmons, S. F. Theories of Ore Deposition Historically Considered	R. 1904	.05
1615	Freshfield, Douglas W. On Mountains and Mankind	R. 1904	.05
1616	Fischer Theobald. Morocco	R. 1904	.05
1617	Newell, F. H. The Work of the Reclamation Service	R. 1904	.05
1618	Lippincott, J. B. The Yuma Reclamation Project	R. 1904	.05

[1] For sale by Superintendent of Documents, Washington, D. C.

1619	DE VRIES, HUGO. The Evidence of Evolution......	R. 1904	.05
1620	COOK, O. F. The Evolutionary Significance of Species	R. 1904	.05
1621	VIVIAN, R. A. Some Bird Life in British Papua....	R. 1904	.05
1622	Bird Sanctuaries of New Zealand.................	R. 1904	.05
1623	SKINNER, J. O., U. S. Army. The House Sparrow..	R. 1904	.05
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1646	SYMONS, THOMAS W. The Projected New Barge Canal of the State of New York.................	R. 1904	.05
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1648	BROWN, ERNEST W. George Gabriel Stokes........	R. 1904	.05
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1650	HERTWIG, OSCAR. Carl Gegenbaur.................	R. 1904	.05
1651	BARUES, CARL. A continuous Record of Atmospheric Nucleation	C.K. XXXIV	.75

1652	TRAVERS, MORRIS W. (With A. G. C. Gwyer and F. L. Usher) (Hodgkins Fund.) Researches on the Attainment of Very Low Temperatures. Part II.—Further Notes on the Self Intensive Process for Liquefying Gases	M.C. XLIX	.10
1653	Twenty-third Report, Bureau of American Ethnology, 1901–'02[1]		2.50
1654	LANGLEY, S. P. Report of Secretary of the Smithsonian Institution for year ending June 30, 1905	R. 1905	.10
1655	Annual Report of the Smithsonian Institution for year ending June 30, 1904, Part 2, National Museum[1]	M.R. 1904	.60
1656	Smithsonian Miscellaneous Collections, *Quarterly Issue*, vol. III, Part 3 (containing Nos. 1657–1664)	M.C. XLVIII	.50
1657	DYER, HARRISON G., and KNAB, FREDERICK. The species of Mosquitoes in the Genus Megarhinus (*Quarterly Issue*)	M.C. XLVIII	.10
1658.	SCHROTTKY, C. A Contribution to the Knowledge of some South American Hymenoptera, chiefly from Paraguay (*Quarterly Issue*)	M.C. XLVIII	.10
1659	LYON, MARCUS WARD, JR. Description of a New Squirrel of the Sciurus Prevostii Group from Pulo Temaju, West Coast of Borneo (*Quarterly Issue*)	M.C. XLVIII	.05
1660	LYON, MARCUS WARD, JR. The Squirrels of the Sciurus Vittatus Group in Sumatra (*Quarterly Issue*)	M.C. XLVIII	.15
1661	HEADLEE, THOMAS J. A study in Butterfly Wing-Venation, with special regard to the radial vein of the front wing (*Quarterly Issue*)	M.C. XLVIII	.15
1662	GILL, THEODORE. Some Noteworthy Extra-European Cyprinids (*Quarterly Issue*)	M.C. XLVIII	.20
1663	DALL, WILLIAM HEALEY. A Review of the American Volutidæ (*Quarterly Issue*)	M.C. XLVIII	.15
1664	Notes to Quarterly Issue, vol. III, Part 3	M.C. XLVIII	.05
1665	Annual Report of the Smithsonian Institution for year ending June 30, 1905, Part 2, National Museum[1]	M.R. 1905	.30
1666	Annual Report of the Smithsonian Institution for year ending June 30, 1906, Part 2, National Museum[1]	M.R. 1906	
1667	Annual Report of the Smithsonian Institution for the year ending June 30, 1905	R. 1905	

[1] For sale by Superintendent of Documents, Washington, D. C.

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VOL. III QUARTERLY ISSUE PART 4

THE BREEDING HABITS OF THE FLORIDA ALLIGATOR

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While collecting material with which to study the development of the alligator, I have had the opportunity, during parts of three summers, to study, at first hand, the habits of this interesting reptile. The first occasion was in 1901, when I went into the Everglades to the west of Palm Beach, Florida: this expedition was undertaken partially under the auspices of the Elizabeth Thompson Science Fund, and was unfortunately cut short before much could be accomplished. The second trip was in the summer of 1905, under the auspices of the Smithsonian Institution: six weeks were spent among the small lakes and sloughs of central Florida, far from the usual haunts of tourists and hunters. During this time nearly one thousand alligator eggs were collected, and considerable information in regard to the breeding habits of the alligator was obtained. A short visit was also made, on the way north, to the Okefenokee Swamp in Georgia. In the summer of 1906 the Okefenokee was again visited; this time the swamp was penetrated to its centre, and nearly one hundred alligators were killed by the three hunters with whom I was traveling. It is this vigorous hunting, done chiefly at night, with a bull's eye lantern and shot gun, that has so diminished the numbers of alligators that where, twenty years ago, hundreds could be seen, to-day scarcely one may be found. It seems a very wanton destruction of life to kill so many of these large animals, especially when it is remembered that a large alligator hide is worth to the hunter only about $1.50.

Just how soon (if at all) the alligator is likely to be exterminated in our southern states it is impossible to say, but so long as those

two great swampy wastes, the Everglades and the Okefenokee, remain undrained, the great American reptile is not likely to become entirely extinct.

One of the first things to be determined, of course, in the collection of embryological material is the time at which the eggs are laid. Judging from the statements of native hunters the laying season of the alligator might be thought to be at any time from January to September. As a matter of fact the month of June is the time when most, if not all, of the eggs are laid. S. F. Clarke gives June 9th and June 17th as the limits of the laying season in Florida, but I found at least one nest in which eggs were laid as late as June 26th: no eggs were found before the first date given by Clarke. It seemed quite certain that the laying, during the season in question, had been delayed by an extreme drought that had dried up the smaller swamps and reduced the alligator holes to mere puddles. Nests were found in considerable numbers as early as June 8th, but no eggs were laid in any of them until the end of the dry period which occurred nearly two weeks later. Almost immediately after the occurrence of the rains that filled up the swamps eggs were deposited in all of the nests at about the same time. From the fact that all of these completed nests had stood for so long a time without eggs, and from the fact that all of the eggs from these nests contained embryos in a well advanced state of development, it seemed evident that the egg-laying had been delayed by the unusually dry weather. Eggs taken directly from the oviducts of an alligator that was killed at this time also contained embryos that had already passed through the earlier stages of development. Thus it was that the earliest stages of development were not obtained during this summer.

It is said that during the mating season, which precedes by some time, of course, the laying season, the males are noisy and quarrelsome, and that they exhibit sexual characteristics of color by which they may be distinguished from the females. Never having been in the alligator country at this season, the writer has made no personal observations along these lines, but from the frequency with which alligators with mutilated or missing members are found it is evident that fierce encounters must sometimes take place, whatever the cause. During June and July, at least, and, probably, during most of the year the alligators are very silent, an occasional bellow during the very early morning hours being the only audible evidence that one has that the big reptiles are in the neighborhood. Whatever may be the sexual differences during the mating season, at ordinary times the two sexes are so much alike that I have, on

more that one occasion, seen experienced hunters disagree as to the supposed sex of an alligator that had just been killed.

Although I have never seen a nest actually during the process of construction, it is easy to imagine, after the examination of a large number of freshly made nests, what the process must be like.

The alligator, probably the female, as the male, after the mating season, takes no interest whatever in the propagation of his species, selects a slight elevation on or near the bank of the "hole" in which she lives. This elevation is generally, though not always, a sunny spot, and is frequently at the foot of a small tree or clump of bushes. Where the alligator is living in a large swamp she may have to go a considerable distance to find a suitable location for her nest; when her hole is scarcely more than a deep, overgrown puddle, as is often the case in the less swampy regions, she may find a good nesting place within a few feet of her cave. That the female alligator stays in the neighborhood of her nest after she has filled it with eggs seems pretty certain, but that she defends it from the attacks of other animals is extremely doubtful: certainly man is in very little danger when he robs the nest of the alligator, and, according to the statement of reliable hunters, bears are very persistent searchers for and eaters of alligator eggs. Having selected (with how much care it is impossible to say) the location for the nest, the alligator proceeds to collect, probably biting it off with her teeth, a great mass of whatever vegetation happens to be most abundant in that immediate vicinity. This mass of flags or of marsh grass is piled into a conical or rounded heap and is packed down by the builder repeatedly crawling over it.

There is a great deal of variation in the size and form of the different nests, some being two meters or more in diameter and nearly a meter in height, while others are much smaller in diameter and so low as to seem scarcely more than an accidental pile of dead vegetation. It is probable that the nests are under construction for some time, perhaps to give time for the fresh vegetation of which they are composed to ferment and soften, and also for the material to settle into a more compact mass. The compactness of the alligator's nest was well illustrated one day when the writer used an apparently deserted nest as a vantage ground from which to take a photograph: on opening this nest it was found, after all, to contain eggs, and though some of the eggs were cracked, none of them were badly crushed. This nest although it was so low and flat that it was thought to be one that had been used during some previous season, contained forty-eight eggs, a greater number than was

found in any other nest; while in other nests that were twice as large as this one were found less than half as many eggs, showing that there is no relation between the size of the nest and the number of eggs. The average number of eggs per nest, in the twelve nests that were noted, was thirty-one. One observer reported a nest that contained sixty eggs, but this, if true, was a very unusual case. Reports of still larger numbers of eggs in one nest probably refer to crocodiles, which are said to lay one hundred or more eggs in a nest. Although crocodiles may be found in certain parts of Florida, the writer has had no opportunity of observing their nesting habits.

The eggs are laid in the nest without any apparent arrangement. After the nest has been prepared, and has had time to settle properly, the alligator scrapes off the top, and lays the eggs in a hole in the damp, decaying vegetation; the top of the nest is again rounded off, and it is impossible to tell, without examination, whether the nest contains eggs or not.

As to whether the same nest is used for more than one season there is a difference of opinion among alligator hunters, and the writer has had no opportunity of making personal observations.

While it is usually stated that the eggs are incubated by the heat of the sun, it is held by some observers that the necessary heat is derived not from the sun but from the decomposition of the vegetable matter of which the nest is composed. Possibly heat may be derived from both of these sources, but it seems likely that the conditions that are especially favorable to normal incubation are moisture and an even, though not necessarily an elevated temperature. Moisture is certainly a necessary condition, as the porous shell allows such rapid evaporation that the egg is soon killed if allowed to dry. The inside of the nest is always damp, no matter how dry the outside may become under the scorching sun, so that this condition is fully met. The eggs of the Madagascar crocodile, according to Voeltzkow,[1] offer a marked contrast to those of the alligator. Instead of being laid in damp nests of decaying vegetation, they are laid in holes that are dug in the dry sand, and are very sensitive to moisture, the early stages, especially, being soon killed by the least dampness.

The daily range of temperature in the southern swamps is sometimes remarkably great, so that if the eggs were not protected in some way they would often pass through a range of temperature of

[1] Voeltzkow, A., The Biology and Development of the Outer Form of the Madagascar Crocodile. Abhandl. Senckberg. Gesell., Bd. 26, Hft. I.

possibly fifty degrees or more; while in the center of a great mass of damp vegetation they are probably kept at a fairly constant temperature. Unfortunately no thermometer was taken to the swamps, so that no records of the temperatures of alligator nests were obtained, but it was frequently noticed that when, at night or very early in the morning, the hand was thrust deep into the center of an alligator's nest the vegetation felt decidedly warm, while in the middle of the day, when the surrounding air was, perhaps, fifty degrees (Fahrenheit) warmer than it was just before sunrise, the inside of the same nest felt quite cool. It is probable, then, that the conditions of temperature and moisture in the center of the nest are quite uniform. One lot of eggs that had been sent from Florida to Maryland continued to incubate in an apparently normal way when packed in a box of damp sawdust, the temperature of which was about 80 degrees Fahrenheit. Another lot of eggs continued to incubate, until several young alligators were hatched, in the ordinary incubator, at a temperature of about 95 degrees Fahrenheit.[1]

The fact that eggs taken directly from the oviducts of the cold-blooded alligator contain embryos of considerable size seems to indicate that no such elevation of temperature as is necessary with avian eggs is necessary with the eggs of the alligator.

The complete process of incubation probably extends through a period of about eight weeks, but no accurate observations along this line could be made. For some hours previous to hatching the young alligators make a curious squeaking sound inside the shell, that may be heard for a distance of several yards: this sound may be for the purpose of attracting the attention of the female alligator, who will open the top of the nest in time to allow the just hatched alligators to escape: unless thus rescued, it would seem impossible for the little animals to dig their way out from the center of the closely packed mass of decaying vegetation.

At the time of hatching the alligator is about eight inches in length, and it seems impossible that it should have been contained in so small an egg.

The size of alligator eggs, as might be expected, is subject to considerable variation. In measuring the eggs a pair of brass calipers was used, and the long and short diameters of more than four hundred eggs were obtained. A number of eggs of average size, when weighed in mass on the scales of a country store, gave an average of 2.8 oz. per egg.

[1] Reese, A.M., "Artificial Incubation of Alligator Eggs." *Amer. Nat.*, March, 1901, pp. 193–195.

There was more variation in the long diameter of eggs than in the short diameter.

The longest egg of all those measured was 85 mm.; the shortest was 65 mm. The widest egg (greatest short diameter) was 50 mm.; the narrowest egg (least short diameter) was 38 mm.

The average long diameter was 73.742 mm.; the average short diameter was 42.588 mm.

The greatest variation in long diameter in any one nest of eggs was 15.5 mm.; the greatest variation in short diameter in the eggs of any one nest was 11 mm.

The average variation in the long diameter of the eggs from the same nest was 11.318 mm.; the average variation in the short diameter of the eggs from the same nest was 5.136 mm.

It will be seen from the above that the average variation in the long diameter of eggs from the same nest is between one-sixth and one-seventh of the long diameter of the average egg; while the average variation in the short diameter of the eggs from the same nest is less than one-eighth of the short diameter of the average egg.

S. F. Clarke[2] gives the limits of the long diameter as 50 mm. and 90 mm., and the maximum and minimum short diameters as 45 mm. and 28 mm. No such extremes in size were noticed among the eight hundred or more eggs that were examined.

EXPLANATION OF PLATES

PLATE LXV

FIG. 1.—Jackson Slough; near Lake Kissimmee, Florida. In the vicinity of this pond several alligator nests were found, either within a few yards of the edge, or on the banks of smaller "holes" which were connected with the larger pond by narrow "trails."

FIG. 2.—A typical 'gator "hole." Only a few yards across, and surrounded by a dense growth of vegetation. On the far side is seen an opening in the surrounding grass and flags where the ground is worn smooth by the alligator in crawling out of the hole. Under the bank, probably near the place where the alligator "pulls out," is the deep cave into which the inhabitant of this hole quickly goes on the approach of danger. As this cave may be fifteen or twenty feet deep it is not an easy matter to get the animal out. When a female alligator inhabits such a hole, a nest may often be found within three or four yards of the water, though it is sometimes at a greater distance. Such a hole as this may be connected by narrow, winding "trails" with larger ponds, as noted under Fig. 1.

[2] *Journal of Morphology*, Vol. V.

FIG. 1. JACKSON SLOUGH; NEAR KISSIMMEE, FLORIDA.

FIG. 2. A TYPICAL 'GATOR "HOLE."

FIG. 3. ALLIGATOR'S NEST, CHIEFLY GRASS.

FIG. 4. ALLIGATOR'S NEST; CHIEFLY FLAGS, OPENED TO SHOW EGGS

PLATE LXVI

FIG. 3.—A typical alligator's nest, made chiefly of grass. The guide is feeling for eggs without disturbing the outside of the nest. Being made of the same material as the background, the nest does not stand out very sharply, though in nature the contrast is somewhat more marked, owing to the fact that the surrounding grass is green while the grass of which the nest is built is dead and brown.

FIG. 4.—An alligator's nest, somewhat smaller than the one represented in Fig. 3, built chiefly of flags. The nest has been opened to show the irregularly arranged mass of eggs inside. The size and shape of the egg is shown by the one in the guide's hand.

LIFE HISTORIES OF TOADFISHES (BATRACHOIDIDS), COMPARED WITH THOSE OF WEEVERS (TRACHINIDS) AND STARGAZERS (URANOSCOPIDS)

By THEODORE GILL

The toadfishes are prominent objects along the American seaboard and inquiries are frequent as to their habits and value. The inquirer is generally told that little is known about them but there is really a considerable literature respecting one species at least, although so scattered that it is known to extremely few and not even to many good ichthyologists. Data have consequently been brought together in the present communication from many sources. There are also a couple of other families whose habits are little known, but which, for different reasons, are of much interest. One is that of the weevers or Trachinids, famed for the venomous character of liquid secreted in pouches connected with opercular and dorsal spines and therefore comparable with some of the Batrachoidids (*Thalassophryne*). The other is that of the stargazers or Uranoscopids, whose species bear considerable superficial resemblance to the toadfishes of the genus *Thalassophryne* as well as to the weevers. There is doubtless a relationship between the three families and, although distant, closer than has been generally admitted. For this reason the habits of representatives of the two families are given for comparison with those of the toadfishes.

The behavior of a number of individuals of the common toadfish of the eastern American coast has been a favorite subject of observation for several years. The observations were made in the aquariums of the Bureau of Fisheries but in past years opportunities were afforded for earlier ones along the coasts of New York and New Jersey. To such observations have been added the records of those of others.

I. The Toadfishes or Batrachoidids

The *Batrachoidids,* or *toadfishes,* are a small family of remarkable fishes not very much like any others, and well defined. They have an oblong form, a broad flattish head, restricted lateral gill-openings,

two dorsal fins, the anterior very small and with only two or three spines, the second very long, the anal moderately long, the pectorals broad, and the ventrals jugular and imperfect (1, 2 or 3-rayed). The most distinctive characteristics, however, are hidden by the skin and muscles and relate especially to the structure of the vertebræ, skull, shoulder girdle, and bones at the bases of the pectoral fins. The most striking character is the development of five well developed and elongated actinosts instead of four as in the great majority of fishes; the peculiar forms of these are well shown in the accompanying drawing by Mr. and Mrs. E. C. Starks. The

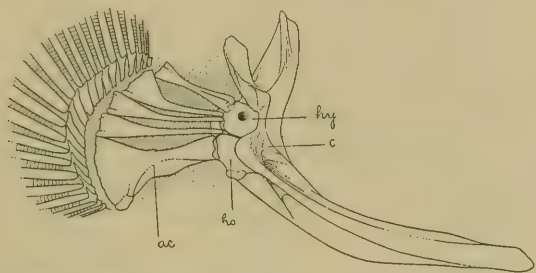

FIG. 103.—Toadfish's shoulder girdle. *ac*, Actinost 5; *c*, cœnosteon or principal bone; *ho*, hypocoracoid; *hy*, hypercoracoid. Original by Starks.

skull is flat and divided into two parts, a narrow anterior fronto-rostral and an abruptly widened parieto-occipital. The want of a suborbital chain of bones is a marked characteristic.

The species are not numerous—about twenty—but the differences among them are such as to have led ichthyologists to distinguish as many as seven genera. One of these is *Opsanus* represented by a common species along the Atlantic seaboard of the United States, and another *Porichthys*, typified by one along the Pacific coast.

The common name toadfish by which the Batrachoidids are almost universally known in the United States is elsewhere used in a very different sense, and even in the United States it is locally applied to other fishes. In Florida it is almost as generally used for the Malthids as for the Batrachoidids. Sometimes it is given to the Tetraodontids, more generally known as swell-toads or puffers. Occasionally, too, it is heard in connection with Antennarioid fishes, otherwise known as the frog-fishes. With a qualifying prefix it is also used for still other forms. According to Mr. Barton Bean, in parts of Florida poison toad or toadfish is applied to species of *Scorpæna* and electric toad is a name for the Astroscopes; at

FIG. 104.—European toadfish (*Batrachoides didactylus*). Skull from above. After Steindachner.

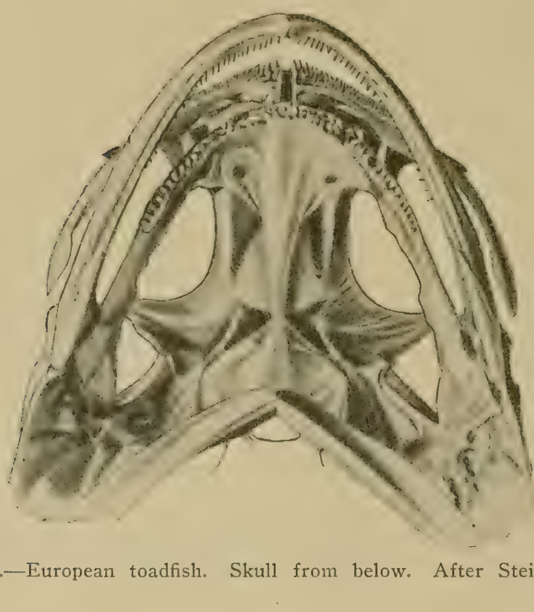

FIG. 105.—European toadfish. Skull from below. After Steindachner.

Beaufort, N. C., species of *Prionotus* are designated as flying toads. In England, toadfish is a little used synonym of the angler. In other countries, where the Batrachoidids are unknown, the Tetraodontids are almost universally designated as toadfishes, and the name in Australia and the Cape Colony always suggests those fishes and those only. Sapo is the Spanish equivalent of toad and in partly Spanish-speaking countries, as Florida and California, the name is used for the Batrachoidids.

Opsanus

The genus *Opsanus* has a naked and rather loose thick skin and the head more or less beset with skinny tags; the opercle has two

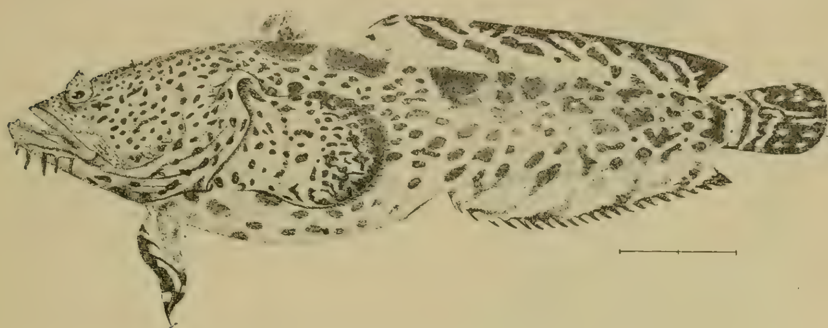

Fig. 106.—Southern toadfish (*Opsanus pardus*). After Goode.

divergent spines, the suboperculum two nearly parallel spines, or rather branches of one spine, of which the lower is much shorter, and the spinous dorsal has three short stout spines. The upper surface of the cranium has a median longitudinal ridge, and also a transverse one, together forming a T-shaped figure which is quite prominent in a dried skin, and suggested to Linnæus the singular name (tau, Greek for T) which he gave to the common species.

Like some others, but not all of the family, the toadfishes of the genus *Opsanus* have a pair of pocket-like sacks opening externally, one on each side, by a pore in the axil of the pectoral fin. The function of these sacks is unknown. Sörensen (1884) compared them with similar sacks of catfishes (Silurids), concerning which he remarks that " it would not be unreasonable to suppose that we had to deal with a case of poisonous secretion. But such an explanation cannot be considered acceptable, both because the sack can by no means be said to open close to the spine, and also because the only fishes probably in which an at least analogous

condition obtains are *Batrachoidids,* in which the pectoral fin-rays are all soft and entirely incapable of wounding. In *Opsanus tau* there is found at the angle formed by the inner surface of the pectoral fin placed vertically to the body a large round opening (2 mm. in a female measuring 18 centimeters in total length), leading into a cavity on the inner surface of which there are about 15 lengthened tubular glands whose secreting cells are club-shaped, cylindrical, and uncommonly large (0.275 mm. long). The contents are either a fine-grained or a clear yellow substance, strongly refracting the light and resembling oil; it has a central position and is about half as large as the transverse diameter of the cell. The whole glandular mass has a pea-like form and is slightly compressed; its largest diameter (in height) is 8 millimeters."

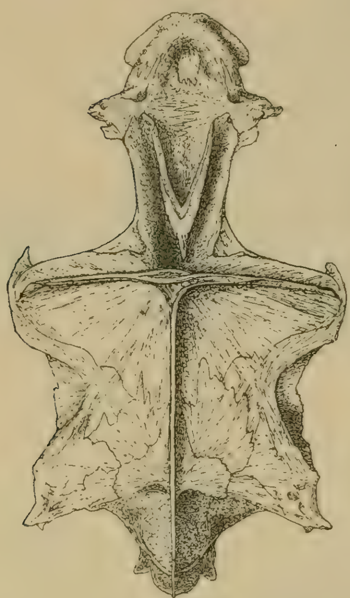

FIG. 107.—Common toadfish's skull from above. Original by Starks.

The toadfishes are emphatically ground fishes and inhabit a long reach of the eastern American coast from the Gulf of Mexico and Cuba to Cape Cod; Jordan and Evermann well express the facts in the statement that the northern form is "very abundant among rocks and weeds close to the shore northward,—in deeper water southward."

According to Goode (1884), "the bottom temperature of the water frequented by these fish would appear to range from 50° F. to 90° F.," the latter extreme, of course, being quite exceptional. "In the more northern regions throughout which they are distributed they appear to become torpid, or nearly so, in winter." They are very hardy and tenacious of life, and will survive, for hours, exposure in the dry air and "soon recover their ordinary activity when restored to the water."

In clear water, where circumstances favor, toadfishes may be seen, prone on the ground, mostly lying down for their full length, but not seldom more or less curved, and somewhat upraised at the head end; generally one is partly hidden by an overlying stone or weeds but, although assimilated to the color and appearance of its

environments, a sharp eye can detect it. An early observer (Ayres with Storer in 1853) gave quite a graphic account of observations in Massachusetts of one of several conditions. "Examining the places where the water is but a few inches in depth at low tide, we see that under many of the stones and smaller rocks the sand on one side has been removed, leaving a shallow cavity, perhaps a foot in width, and extending back beneath the stone. If we approach this cautiously, we shall probably distinguish the head of a toadfish very much in the position of that of a dog as he lies looking out of his kennel. The fish is at rest and might be overlooked by a careless observer; a closer attention, however, readily distinguishes the curve of its broad mouth and delicately laciniated tentacles with which its jaws and other parts of its head are ornamented. Its eyes, and sometimes the anterior portion of its body, are truly beautiful. At the slightest alarm it retreats beneath the stone, but presently reappears; it is lying here merely as in a safe resting place, perhaps on the watch for its prey."

When at rest, its attitude is quite characteristic; its head is somewhat tilted, sometimes supported by a stone, a sloping decline of sand or mud, or, it may be, on the body of a companion. The fins, unlike those of most fishes, are often maintained erect, the first as well as second dorsal being completely upraised, while the caudal may be almost folded; the pectorals are near the sides but with the lower edges everted and borne on the ground; a slow movement of inspiration and expiration is kept up, the jaws being very slightly open and moved, and the gill-membranes slightly puffing and collapsing in harmony; otherwise the fish is motionless. Different individuals, however, may assume very diversiform attitudes, and some coil themselves up so that the tail touches the gills or, may be, is tucked under a pectoral fin. Where many are together, they may congregate in a heap in some retired nook. The eyes present rather a remarkable appearance, the pupils changing from greenish to bluish or blackish, according to the incidence of light, and the irises are traversed by St. Andrew's crosses. The element of beauty in such must be a matter of opinion. In contrast with Ayres, Baird thought that "few fishes are more repulsive in appearance" on account of "the laciniated processes or fringes about the jaw, goggle eyes, and slimy body."

The crowding together of many individuals just alluded to is a characteristic habit in aquaria at least. The toadfish is not a schooling or social animal as generally understood but there are very few others who will associate as closely as it does. All the fishes

in a toadfish aquarium may occasionally be found massed together in a regular heap, as close together as possible, in some selected corner, some on top of the others. In such positions some may remain quite a long time (perhaps an hour even) and most of them scarcely move; there will be often some restlessness, nevertheless, and from time to time one or more may leave and swim about or possibly seek another corner. Generally, however, there are several

FIG. 108.—Common toadfish in characteristic posture. After Lesueur.

(one or more) moving about in another corner. When compelled at length to move away from its resting place a fish will progress with a wriggling movement, well represented in the accompanying figure,[1] and the soft dorsal fin especially is subjected to a rather rapid and regular undulatory action, reminding one of a screw propeller. If roused by a stick to action, the disturbed fish's first impulse is to snap at the offending instrument, and perhaps one in its anger may swallow a lot of pebbles, to disgorge when at rest again.

Most toadfishes are voracious and "almost omnivorous." The assumption of Günther ("all of the Batrachoids with obtuse teeth in the palate and in the lower jaw feed on mollusca and crustaceans") is only half true. Besides crustaceans, mollusks and worms, it preys on such small fishes as it may be able to catch, "especially upon Anchovies and Sand-Smelt." Verrill (1871) found that the large stomach was "usually distended with a great variety of food," enumerated various species he had identified, and deduced the proposition that "the toadfish is, therefore, a fish that should not be

[1] The figure of the sinuous toadfish is a reproduction of an illustration prepared about 1823 by Lesueur, "the Raffaele of zoological painters," the first ichthyological artist of his time.

encouraged." From Stearn's observations, it appears that "it secures its food rather by strategy and stealth than by swiftness of motion; hiding under or behind stones, rocks or weeds, or, stealing from one cover to another, it watches its victim until the latter is near by, when it darts forth with a quickness quite astonishing, considering its usual sluggishness, and back again to its hiding place, having one or more fish in its stomach and alert for others."

A number of individuals were dissected by E. Linton at Woods Hole (1901) as well as at Beaufort, N. C. (1905), and various shells and crustaceans were the principal contents. The univalve shells were mostly such as had been appropriated by hermit crabs for their own use, and the crustaceans, besides such hermit crabs, were shrimps (*Palæmonetes vulgaris*, etc.) and true crabs of various species; other univalve shells (such as *Ilyanassa*, *Urosalpinx*, *Crepidula*, etc.) and bivalves, especially scallops (*Pecten irradians*), had evidently been swallowed for the mollusks. Remains and fragments of fishes also were found and among them "a partly digested toadfish." A still more decided case of cannibalism fell under Linton's observation, for he had "seen a toadfish in the aquarium in the act of swallowing another of its own species but little smaller than itself." Sea-urchins (*Arbacia*) were also found in several fishes, and in one "no entozoa were found," and it appeared to Linton "that the diet of sea-urchins had in this case acted as an anthelmintic."

The strength of the jaws is wonderful in a fish of its size, although it rarely tries to bite unless provoked to do so. If, however, it is incautiously or roughly handled it will snap "at the finger, even when almost dried up," according to Baird. He aptly adds, "it is capable of inflicting quite a severe bite, and is always handled with a great deal of caution." One who is bitten by a large fish will not soon forget the impression left on him—the writer has had experience and speaks from feeling. There is, however, individual or environmental difference between toadfishes, and even the same fish may manifest difference of moods. Goode's experience was quite different from the present writer's, for he found (1884) that "when touched they show no disposition to bite, but erect their opercular spines in a very threatening manner."

A certain power of utterance is exercised when they are taken from the water for sometimes, when handled, they utter a loud croaking noise. But this power is also manifested in the water of their own volition, and has even obtained a distinctive name for the fish.

Captain Charles B. Hudson recently informed Dr. W. C. Kendall, that "when he was making color drawings of fishes at Key West, Fla., in the spring of 1897, he had for a studio a small hut on a pier some distance from shore. Frequently while at work there, under and near the pier, he heard a sound having somewhat of a musical quality, presumably produced by some fish, the identity of which for a long time he could not make out. The nearest verbal approach to the sound was 'kūng-kūng,' or 'koong-koong,' about the same pitch and time being given to both parts of the word or sound. Fisherman said it was a fish which from its voice they called 'Kung-Kung,' but no one had ever seen the fish to recognize it. Later Mr. Hudson caught a toadfish (*Opsanus pardus*) and placed it in a bucket or pan of water on the floor of the building where he was at work and ere long heard the sound, this time within the hut. He thus ascertained that it was the toadfish that was the mysterious songster. How the sound was produced he did not learn."

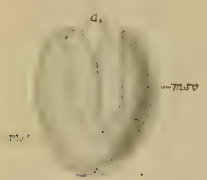

FIG. 109.—Common toadfish's air bladder. *a*, Anterior lobes of air bladder; *mso*, musculus sonans. After Sörensen.

W. Sörensen, in a work on the sound producing organs of fishes (Om Lydorganer hos Fiske, 1884), declared that the sounds emitted by the toadfish are produced by the air-bladder and the contraction and relaxation of the muscles of the bladder. The viscus has a characteristic form; it is rather small—about a ninth of the length of the fish—and nearly double, being so deeply divided that it appears as if paired for the greater part of its length and is only continuous behind; it is described by Sörensen as follows:[1] Above, the division extends backward half as far again as on the underside. The inner surface of the air-bladder presents no projecting membranous partitions or the like. The outer membrane is strong, tough, fibrous and rigid; the inner somewhat thicker than usual. On the sides of the air-bladder are found a couple of large muscular bands, especially thick behind, which cover more than half the surface of the organ. On the underside they do not extend as far toward the middle as on the upper surface, where they meet behind. The muscular fibers run transversely but at the same time somewhat obliquely backwards (on the ventral side beginning at the middle, on the upper side toward the middle); towards the hinder end of the organ the fibers gradually run evenly transversely. The pleura is strong, but rather thin; it is, however, thicker behind on the backside, where the muscle bands meet.

[1] Translated from the Danish.

On the approach of cold weather the toadfishes retreat from the shallow to deeper water and, according to Ayres (1842), "bury themselves in the mud and remain torpid, and are very frequently brought up with the spear while striking in the mud for eels." One was carried to Ayres "which had been taken in this manner, October 27, 1840; it was torpid and lived nearly twenty-four hours without water."

Having received protection during the winter, in its muddy retreat or water of considerable depth, from the conditions superinduced by the cold of the northern states, in the summer toadfishes closely approach the shore; this movement is to a large extent at least induced by the procreative instinct. In the southern states, the approach to shore and the reproductive season commence earlier—in the Gulf of Mexico "in April or May." The females and males seek suitable places for the deposit of the eggs and the duties of reproduction are duly assumed by the respective sexes. The eggs are large—very large as fish eggs go and almost as big as a wolf-fish's; they have diameters of "from 5 to 5½ millimeters," en-

FIG. 110.—Common toadfish eggs on Pinna shell. After photograph by E. W. Gudger.

larged by the extent of the yolk, devoid of oil-globules, and "dirty yellow, almost amber-colored." They are fastened "to the surfaces of submerged objects" of stone, wood, or what not, and "a discoidal area" or disk, "about 3 millimeters in diameter at the upper

surface of each egg, glues the latter firmly to the supporting surface." Preference is manifested for the undersides of boulders," when such are present, and under them "the parent fish seem to clear away the mud and thus form a retreat in which they may spawn." (Where stones are absent the insides of oyster or other bivalve shells are selected.) The eggs may be "attached to the roof of the little retreat prepared by the adults, where the eggs are found spread over an area about as large as one's hand in a single layer, hardly in contact with each other, and to the number of about 200."

Fertilization of the eggs "probably occurs at the time of their extrusion by the female," after which she retires, manifesting no further interest in the deposit. "The male at once assumes the care of the brood and seems to remain in the vicinity until the young fish are hatched and set free."

According to Ryder,[1] "remarkable is the fact that as development proceeds the young adherent embryos are found to have their heads directed towards the opening of their retreat and their tails

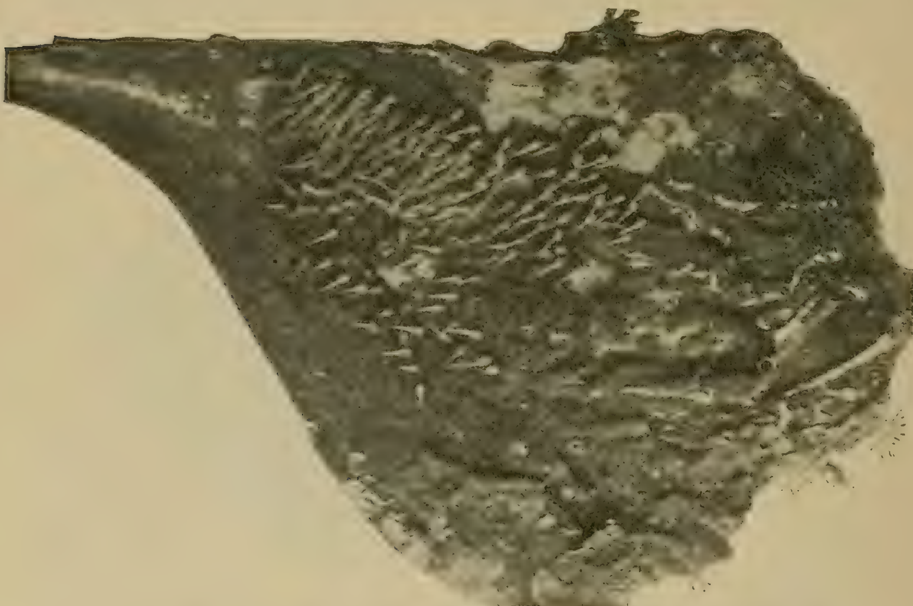

FIG. 111.—Common toadfish's newly hatched larvæ on Pinna shell. After photograph by E. W. Gudger.

towards its blind and dark extremity. This appears to be invariably the case, and it would seem that the direction from which light

[1] Bull. U. S. Fish Com., VI, 1886, 77–80; Am. Nat., XX, 77–80.

comes, in this instance, at least, has a great deal to do in determining the direction of the axis of the body of the future embryo. This position of the young fishes is maintained as long as they are attached."

Miss Wallace found (1898) that "not until the fourth or fifth day after fertilization does a distinct axial thickening appear."

The period of incubation was supposed by Ryder to be about 15 to 20 days, but by him "the exact duration of its development was not determined." "While the embryos are still adherent, the tail is not kept constantly vibrating, but the pectoral fins are kept in motion so as to keep up currents of water and effect the constant change of the latter, needful for the respiration of the embryos." Meanwhile the fins gradually approximate to the adult form, the body grows and the yolk becomes absorbed, and when finally free an unmistakable toadfish has been developed. By the time it has reached a third of an inch (8 mm.) in length, it has assumed the form of maturity and the fins are fairly developed although the heterocercal tail and embryonic fin folds connected with it are still retained; according to A. Agassiz (1882), who has described such a stage, "the whole fish was dotted with small pigment spots, with a few larger cells scattered irregularly over the surface; the pectorals were similarly colored. The general tint of body and fin was gray, with blackish and yellowish pigment cells."

The transition from egg to fish takes a rather long time compared with most fishes. Ryder judged that the fixed condition of the egg and embryo lasts for at least three or four weeks but "the egg membrane is ruptured in about half that time."

The subsequent development also presents some exceptional features. "The development, as it advances, enables the young embryo within the egg membrane to finally rupture the latter immediately over the back, which looks down and away from the surface to which the egg is attached. When the zona or egg-membrane is ruptured, the young fish is, however, not set free at once, as in the case of other adhesive ova, but remains firmly glued to the inside of the zona over a part of the ventral surface of the yolk-bag."

The care of the father, it has been claimed, does not cease with the liberation of the young from the eggs. According to Stearns, "when its young have been hatched, the older fish seem to guard them and teach them the devices of securing food in much the same

[1] Ryder's generalization appears to be rather more categorical than the facts warrant. At least a photograph taken from life by Dr. E. W. Gudger shows several deviations of larvæ from a uniform trend of direction.

manner that a hen does her chickens." He had "spent hours in watching their movements at this time, and was at first much surprised by the sagacity and patience displayed by the parent fish." If piscine intruders appear, he darts at them and drives them away; if a finger is pointed at him, he will snap at it and perhaps hold it for some seconds—if allowed! If driven or taken from his nest, he will return to it as soon as possible.

When released from paternal care the young toadfishes are prone to seek shelter in oyster shells and are not infrequently found between the valves of living oysters. One, 2½ inches long, found in a living oyster, was described by Lesueur (1823).

The subsequent history of a toadfish has not been made known, nor do the specimens in the United States National Museum furnish the necessary data for exact computation.

Goode, at Noank, Connecticut, had an opportunity of watching the progress of the spawning season. July 14, numerous eggs were found clinging to the stones in water one to two feet in depth; later in the season, July 21, young fishes half an inch long were plenty, and September 1, these had attained an average length of one inch. Individuals of the second year's growth were also common and would average perhaps three or four inches.[1] It is probable that maturity is reached in the third or fourth year.

The toadfishes, uncanny and repulsive in appearance as they are generally regarded, are usually rejected by most fishermen and never admitted to the tables of the well-to-do, if by any persons. Nevertheless, they may help to furnish a satisfactory and savory meal. We learn from Stearns that "its flesh is highly esteemed by many of the Gulf fishermen"; these, it may be urged, are mostly ignorant blacks. By eminent men, and good judges, however, the opinion of the Gulf fishermen has been endorsed. Storer testified that "its flesh is delicate and good" and Baird that it is "very sweet and palatable." The present writer tried one many years ago and was favorably impressed by it.[3]

[1] In Goode's article it is stated that "individuals of the second years growth . . . would average three-fourths of an inch in length," a statement contradicted by the context and probably a lapsus calami for three or four inches.

[2] In many parts of Florida the fishermen are whites, especially at Key West, and some of them are quite well informed.

[3] According to Cantor the "*Batrachus grunniens*" of Indian waters is considered by the natives of the Malaccan coast to be poisonous. Pellegrin enumerates it as one of "*Poissons vénéneux*" (1899, p. 95), but adds that no confirmatory experiments have been signalized.

Goode (1885) forecast for the toadfish an acceptability which it did not enjoy in his time; it may, he foretold, "be regarded as constituting one of the undeveloped resources of our waters, and it can scarcely be questioned that in future years it will be considered as much more important than at present."

PORICHTHYS

The genus *Porichthys* has a naked skin with several longitudinal rows of pores and shining spots, head smaller and less broad than in *Opsanus,* and with various rows of pores, the opercle chiefly developed as a single spine, the subopercle spineless and little

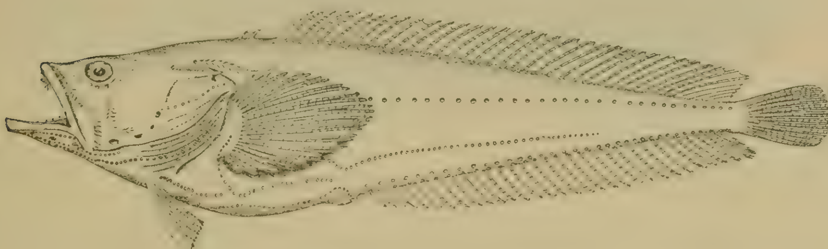

FIG. 112.—*Porichthys porosissimus.* After Jordan and Evermann.

developed, and the spinous dorsal reduced to two spines. The air-bladder has more attenuated anterior pointed divisions than that of *Opsanus.*

This is a genus remarkable for the silvery spots which remind one of the photophores of Scopelids and other deep sea fishes, though they are entirely dissimilar otherwise. The three species are confined to the American waters.

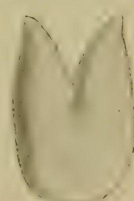

FIG. 113.—Porichthys air bladder. After Kner.

One of the species is common along the Californian coast; it is the *Porichthys notatus,* which attains a length of about fifteen inches. Its popular names are singing-fish, canary-bird-fish, midshipman, cabezon and sapo. "It makes a peculiar humming noise with its air-bladder, hence the name singing-fish," say Jordan and Evermann. It has been asserted by C. F. Holder to make "the loudest noise" he ever "heard made by a fish." One scarcely "a foot long," which he "kept in a tank," would utter "a loud resonant croak or bark under water which could be heard with startling distinctness fifty feet away."

A couple of other genera are noteworthy, one as the name-giving

genus of the family and the other on account of the venomous exudations its species emit.

BATRACHOIDES

The genus *Batrachoides,* the name-giver of the family, is separated from the others by the scaly body and none of its species ascend to such high latitudes as some of *Opsanus* and *Porichthys.* The typical species, *B. didactylus,* is an inhabitant of the Mediterranean sea and the nearby Atlantic coasts, although occasionally wanderers have

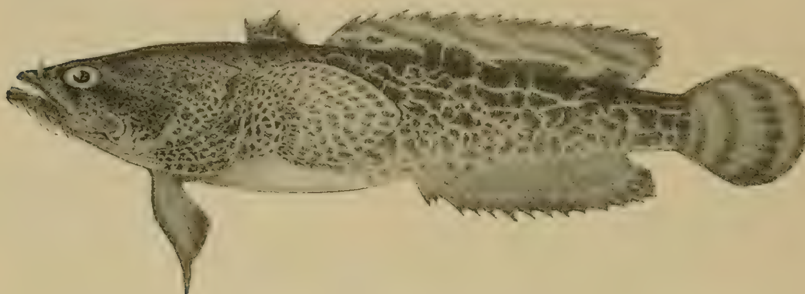

FIG. 114.—European toadfish (*Batrachoides didactylus*). After Smitt.

been found far away. Two species live along the American coasts; one (*B. surinamensis*) occurs in the Caribbean Sea and another (*B. pacifici*) along the coast of Panama and in neighboring waters. Other species are found in the tropical waters of the old world. Little is known of the habits of any of them. Even for the European form Smitt was forced to supply information respecting the genus from data gathered about the common American toadfish rather than from European sources.

THALASSOPHRYNE

The genus *Thalassophryne* has a scaleless skin with only a single lateral line, head moderate and cuboidal, opercles very small and extended backwards into single strong hollowed spines, subopercles spineless, and the first dorsal with two hollowed spines. The hollowed opercular and dorsal spines are connected with special glands at their bases. The species of *Thalassophryne* have a distinctly developed poison apparatus, to some extent analogous to that of the weevers, first elucidated by A. Günther (1864). As just noted, there are hollowed spines to the opercle as well as to the dorsal fin. "The operculum is very narrow, vertically styliform, and very mobile; it is armed behind with

a spine" which reminds one of "the venom-fang of a snake," but is "less curved"; "it has a longish slit at the outer side of its extremity, which leads into a canal perfectly closed and running along the whole length of its interior"; "a bristle introduced into the canal reappears through another opening at the base of the spine, entering into a sac situated in the opercle and along the basal half of the spine." This spine is filled with "a fluid which becomes of a whitish substance of the consistency of thick cream" in specimens

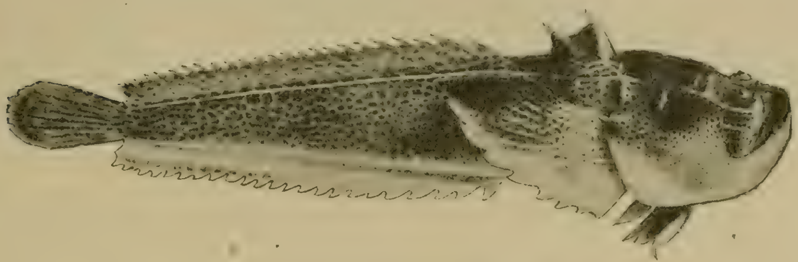

FIG. 115.—*Thalassophryne maculosa.* After Günther.

preserved in alcohol; from the sac "on the slightest pressure," the fluid "freely flows from the opening in the extremity of the spine." The spines of the dorsal, two in number, are also perforate, are slit in front of the tip, and "each has a separate sac" at the base with contents like the opercular sacs. "Thus," according to Günther, "we have four poison-spines, each with a sac at its base, the walls of which are thin, composed of a fibrous membrane, the interior of which is coated over with mucosa."

The natural inference that this apparatus is of a poisonous nature is justified by what is known of the fish. The slightest pressure on the base of a spine causes the poison to jet a foot or more from the spine. According to John M. Dow (1865), "the natives of Panama seemed quite familiar with the existence of the spines and of the emission from them of a poison"; this, "when introduced into a wound, caused fever, an effect somewhat similar to that produced by the sting of a scorpion, but in no case was a wound caused by one known to result seriously."

Three well-marked species have been attributed to the genus; one (*T. maculosa*) inhabits the Caribbean Sea about Puerto Cabello, a second (*T. reticulata*) the Pacific coast of Panama, and a third (*T. dowi*), distinguished by its elongate form, is a compatriot of the second.

Other Genera

Other genera of Batrachoidids are *Halophryne* or *Marcgravia* and *Thallassothia.*

II. The Stargazers.

The *Uranoscopids* or *Stargazers* are a very natural and well defined family readily distinguishable by their form and physiognomy. The general form is oblong and the head more or less cuboidal, with the eyes on the upper surface looking directly upwards; the mouth is almost or quite vertical, the snout being short and the suspensorium for the lower jaw pushing forward; the branchial apertures are very large, procurrent below in front of the pubic bones and covered in front by a fold of skin, continued from the branchiostegal membrane; the dorsal furniture is mostly developed as two fins, a short spinous one and a long soft one, but in a few the spinous fin is obsolete or united with the soft and consequently there is only a single fin; the anal fin is oblong and spineless; the pectoral fins have very wide bases procurrent forwards, and the ventral are close together, inserted far forwards under the throat, and have the normal acanthopterygian structure $(1 + 5)$.

Coincident with these are many other characteristics, superficial as well as anatomical. Granular ossification is variously developed on the roof as well as sides of the head, and a membranous subopercular border is more or less developed and may extend forwards and connect with the fold covering the branchiostegal membrane. The lips are deeply slashed or fringed and the opercular membrane is also sometimes fringed.

The species are inhabitants of warm or temperate waters, some two dozen being known, representing eight or nine genera. Most of the genera are notably distinct and some of the kinds of variation may be realized by comparison of the main characteristics of the European and American species, the former being typical of the genus *Uranoscopus* and the latter constituting the genera *Astroscopus, Kathetostoma* and *Execestides.* It is only some of the most salient characters that are utilized for the distinction of the genera, for there are many more that differentiate them from each other and from other genera.

I

The Uranoscopes (*Uranoscopus*) have the opercles free all around, the branchial apertures extending upwards and forwards in front of the suprascapular region; the skull is completely ossified

above; the preopercles are armed with acute spines directed downwards, each having four or five, and a similar subopercular spine is developed; further, there are two acute spines about each "shoulder" and two pointed forwards from the pelvic bones; the scales are arranged in oblique folds reminding one of those of a

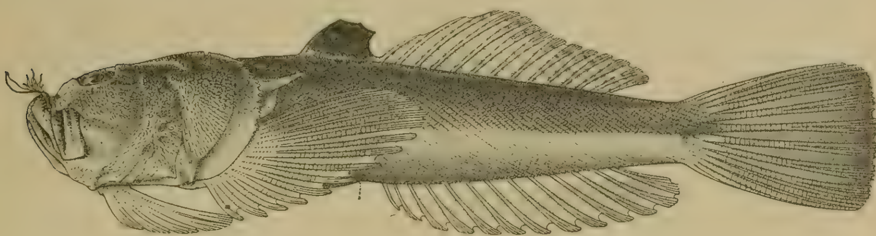

FIG. 116.—European stargazer (*Uranoscopus scaber*). Original by Starks.

Sand-launce (*Ammodytes*) and the spinous dorsal fin has four weak flexible spines; another very striking character is the development of a median protrusile filament or tentacle from the intralabial membrane or "valve."

The common Uranoscope of the Mediterranean was in ancient Greece known as the Agnos, Kallionymos and Ouranoskopos (*Uranoscopus*); the first name was homonoymous with an adjective meaning holy, sacred or chaste; the second (meaning a beautiful or fine name) was perhaps given in an antiphrastic sense to the first; the third (signifying a looker heavenward) was suggested by the position and direction of the eyes. The great physician of old, Galen, alluded to it in connection with a belief held by some among the ancients as well as moderns. "Those who believe that man was made erect so that he could easily look heavenward could never have seen the fish called Uranoscopus which always looks up to heaven in spite of itself."

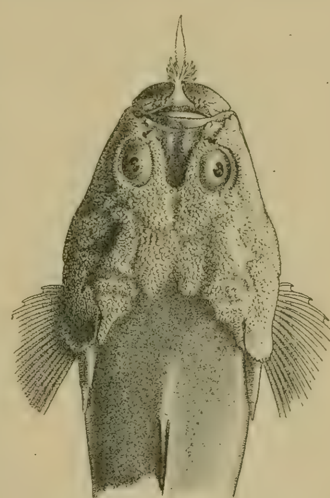

FIG. 117.—European stargazer. Original by Starks.

All these names, however, long ago fell out of use and the name now current in Greece is Lichnos (*Lichnus*) or Luchnos (*Lychnus*). The dominant of the many names in use west of Greece are

lucerna in Italy, rat in France, and rata in Spain. There is no English vernacular name for the reason that the species does not occur in English waters; stargazer is a book-name and translation of the scientific one.

The common Uranoscope is best known as a Mediterranean fish and in suitable stations in that sea it is found through its entire extent, in some places very common, in others moderately so, and in others still it is rare. The only considerable data respecting its habits have been published by R. Schmidtlein (1879) and L. Facciola (1883). Free translations are herewith presented of articles by both authors.[1]

According to Schmidtlein, the stargazer spends the greater part of its life in the mud. It is such a poor swimmer that it sinks to the bottom like a stone, as soon as it suspends the tail and fin movement. The quiet floating practiced by most other fishes at all depths is impossible for it; it is bound to the bottom like the poor flyer among the birds, and here it pursues the treacherous chase with which its heavy physiognomy so well harmonizes. It betrays, by its form, the peculiar manner of life that it leads. The clumsy body, enlarged and wedge-shaped forwards, and provided with powerfully developed pectoral fins; the broadly arched and upturned mouth; and the small mobile eyes situated in the roof of the frontal region, at once indicate the lurker. And, indeed, the first thing newly caught specimens do in the aquarium is to sink into the sand by means of a few vigorous shoveling movements of the pectorals, until only the mouth and eyes project. No movement is discernible in the fish thus buried, and only a very practiced eye is able to discover it and to notice, on careful observation close by, the gentle movement produced by the gills in breathing. Now and then the eyes are turned by jerks like those of a chameleon and watch out cautiously and attentively. We will disturb one! It starts up and swims awkwardly up and down with sidewise pendular beats, meanwhile incessantly thrusting a long vermiform tongue-like filament out of the mouth and drawing it in again. This filament is a structure with a broad basis between the inner angles of the lower jaw, and in an adult is about two to two and one-half centimeters long, and very similar to a thin slimy worm.

On closer examination we find that this filament is a band-like prolongation of the mucous membrane of the mouth, which appears

[1] An accurate figure of *Uranoscopus scaber* was not found in any European work and consequently the accompanying illustrations of the entire fish and its head were made by Mr. E. C. Starks. The intralabial filament is represented more branched than usually manifest in nature.

with an enlarged basis at the inner angles of the lower jaw and tapers gradually toward the free end. The lateral borders have the form of a lobed frill from the basis as far as two-thirds of the length, the lobes decreasing in size toward the point. The whole structure contains throughout an uncommonly rich vascular network which plays a part in the swelling, thrusting out and playing of the filament, as may be specially noted in larger individuals: when active the appendage is almost cylindrical and reddish; while that prepared from a dead fish appears flabby and flattened in a band-like manner. In its broader posterior portion it contains mostly some brown branching pigment spots, while the middle portion and also the largest hinder lobes of the frill are of a dark brown color. The exhaled breath is used in thrusting out the tongue.

In the swimming fish the little appendage plays on the forehead backward between the eyes on account of the pressure of the water, and moves with great rapidity. In a second the act of thrusting out and drawing in is accomplished. After a little the animal again sinks to the bottom, at once buries itself, thrusts out its filament a few times more, and then it lies, motionless as a block, in the sand. Here, however, the playing of the filament appears entirely different. Schmidtlein succeeded several times in watching an individual while it was performing this peculiar manœuver so familiar to fishermen. The ugly lurker lay perfectly concealed in his bed of sand, only the crown of the clumsy head with the eyes and the mouth-cleft being uncovered, and it bore a striking resemblance to a brownish gray stone in its immobility. Slowly the treacherous little filament, so deceptively similar to a mud-inhabiting annelid in shape, size, color and movement, projected out of the mouth. It bent, wound and waved, stretched and contracted, now crawling along the bottom, now playing upward vertically, in short, imitating so perfectly a harmless little worm that not a moment's doubt could be entertained of its significance as a bait for inexperienced young fry, and the assurance of fishermen was not needed that this angling method of the stargazer was an indisputable fact. And the deception is no doubt easier in the ever dusky, soft light in the shallow-seas which the Uranoscope inhabits, than in the light aquarium where it may have difficulty in procuring its food. Schmidtlein saw the fish in the latter place frequently start up from the sand and snatch up a goby or a blenny on a free hunt. But even its own species is not safe from its voracity; in the stomach of one specimen were found four young ones of the same species, each an inch long!

Some quite active and free swimming fishes fall prey to a Uranoscope's voracity. An individual of an Indian species (*Uranoscopus crassiceps*), occurring in deep water (at a depth of about a hundred fathoms), was found by Alcock (1890) with "seven entire individuals of *Scopelus pterotus* besides much debris" in its stomach. This observation is of exceptional interest for two reasons at least. The Uranoscopid is a bottom fish, dependent for its food upon the approach of a victim near enough to be pounced upon, and the Scopelids (Myctophids) devoured must consequently have approached sufficiently close to be so taken, thus indicating that the captured fishes probably had a diurnal range from near the surface to the bottom of the ocean within at least the hundred fathom line.[1] The phosphorescent emanations of the victim fishes were doubtless in this case detrimental to the interests of the fishes for they revealed their approach and facilitated their capture.

When warm weather becomes settled, the stargazers commence to perform their reproductive duties and from early May to late September eggs in various stages of development may be found floating in the water. The eggs have been described by Wenckebach (1886) and Raffaele (1888) and their descriptions and figures give many data respecting their early development. The eggs must be discharged and fertilized during early night ("nelle prime ore della notte," Raffaele says) because those collected in the morning (about seven or eight o'clock) are already quite well advanced in development.

The eggs of a Uranoscope, Raffaele considered, are among the most interesting and characteristic of floating eggs and among the very best for microtomic sections. They are rather large as fish eggs go (1.65 to 2 millimeters in diameter) and distinguishable at first sight by their opacity and whiteness. The opacity depends on the structure of the capsule which is completely covered on the external surface by a regular network of hexagonal meshes; the mesh-like appearance results from transparent elements ("listrelle") perpendicular to the surface of the capsule. The vitellus is homogeneous and in the first stage of development fills the cavity of the capsule; there are no oil-globules. The embryo rapidly progresses in development and while still in the egg-case reaches an advanced state, a true vitelline circulation being established before hatching.

[1] As a matter of fact specimens obtained from dredges cast in the Andaman Sea to the depth of "370 to 419 fathoms" were also identified with the "*Scopelus pterotus*," which is a true *Myctophum* (Ill. Zool: Investigator, Fishes, p. 162). This does not prove that the Myctophids were obtained from such a depth, although they may have been.

The larva after hatching is intensely colored and much less transparent than most pelagic larvæ. The larval fish, nevertheless, has a form not very dissimilar to that of the matured stage, or at least it suggestively resembles it. The internal organs, the mouth, the cartilaginous branchial skeleton, and the primitive cranial cartilages, which are mostly developed in extra-ovarian life, are all manifest in the egg stage.

No data are at hand respecting the postlarval and later development and growth of the fish.

In the countries round the Mediterranean, like almost all other fishes, the stargazer is utilized. Considerable numbers are sold in the French markets of Nice, Toulon, Marseilles, and Cette, often intermingled with other inferior fishes. Their flesh is white but more or less unsavory. According to Risso, the quality depends on the places where the fish live, those frequenting rocky places being the best, and not being as tough (coriaces) as others. They are principally used for making an inferior chowder.

II

The Astroscopes (*Astroscopus*) have the opercles tied by membrane to the shoulders so that the branchial apertures cease a short distance above the level of the pectoral axillæ; the head has a pair

FIG. 118.—*Astroscopus y-græcum*. After Jordan and Evermann.

of naked areas above; the preopercles and subopercles are spineless, and so are the shoulder girdle and pubic bones, thus contrasting pointedly with the corresponding parts of the Uranoscopes, but in compensation the dorsal spines are very robust and pointed. The anterior nostrils are subtubular with fimbriated edges; the posterior have raised fringes continued backwards in curves parallel with the upper margins of the eyes. There is no intralabial tentacle. The differences between the Astroscopes and typical Uranoscopes are, indeed, so many and so great that surprise must be

entertained at the disposition of European ichthyologists to ignore the genus. The habits must be a reflex of the differences of structure.

As the Astroscopes lack the peculiar linguiform extension of the mandibular valve and as the branchial apertures are roofed over by membrane, some of the most characteristic movements of the European stargazers cannot be exercised by the American. Little, however, is known of the habits of any Astroscope. Dr. Hugh M. Smith has made some observations of the common eastern coast species which he has kindly communicated for the present article.

"The stargazer has frequently been kept in the aquarium of the Bureau of Fisheries in Washington. The specimens have come from the lower Chesapeake in September, and have usually remained alive and in good condition until the following spring. The attendants report that the fish can invariably be found in fall at Old Point Comfort and Willoughby Spit, buried in the sand along the line of surf. The species is known to the fishermen of that region as 'sand toad.'[1] The collector for the aquarium states that on several occasions, while wading in the surf with a scoop-net in hand, he has come upon stargazers which in their fright leaped out on the beach instead of into the deeper water. The species is tender and difficult to transport, but is fairly hardy in the aquarium. The normal attitude assumed by the fish in the aquarium is complete self-burial in the sand with the exception of the minute eyes, which are so inconspicuous as to be easily overlooked, so that a tank may contain half a dozen full grown stargazers without a casual observer being aware of the fact.

"The fish prefers live minnows as food, and catches them with great dexterity. When a minnow comes within range, the *Astroscopus* emerges from the sand like a flash, seizes and swallows its prey, settles back in the sand, and conceals itself by a wriggling motion of its body and a fanning of its pectoral fins, the entire act occupying but a few seconds. The elevation of its body resembles the action of a flounder in seizing food, and the tail may remain on the bottom. Dead fish and chopped meat are eaten in the absence of live food. I have made no observations on the electric organ in this species, and the aquarium attendants are not aware of its existence. The fishermen of Beaufort, however, have learned of its presence and call the fish electric toad."

The reference to the "electric organ" of the Astroscope was evoked by the observations of Dr. J. A. Henshall and Professor C.

[1] In parts of North Carolina the Astroscope is called electric toad, according to Mr. Barton Bean as well as Dr. Smith.

H. Gilbert. The naked lateral areas on the upper surface of the head in the midst of the exposed granuliferous bones have been asserted to be the seats of a certain electric manifestation. According to Henshall, it was exhibited by the Florida fish (*A. y-græcum*), and Gilbert (1896), in a note on the Mexican Pacific coast species (*A. zephyreus*), remarked that "a distinct electric shock was given by this fish when alive, the electric organs being in the fleshy areas on top of head behind eyes." Such a manifestation certainly deserves more attention that it has received.[1]

Nothing is known of the embryology and development of any Astroscope. One notable fact in their growth, however, is that the naked areas on the crown and the scales become manifest rather late, for specimens over two inches long are naked (*i. e.,* scaleless) and the naked coronal areas do not stand out in strong relief. On a young specimen the *Uranoscopus anoplus* was based, as well as the genus *Astroscopus.*

Two well-defined species of the genus *Astroscopus* occur along the eastern coast of the United States and may be distinguished as follows:

Astroscopus y-græcum.

Naked postocular areas much longer than wide; preorbital spines reduced to two knobs in the adults; color yellowish brown with oblong spots between larger interspaces; small dots on postocular areas; long spots on back and sides of head, and dots on cheeks; spots, larger and less crowded than those of *A. guttatus,* on back and sides and extending to near the caudal fin; hindmost edge of dorsal fin white.

Astroscopus guttatus.

Naked postocular spaces not longer than wide; two distinctly defined spines on front of preorbital; color dark and reddish brown, with numerous small spots on naked postorbital areas and on sides, becoming larger backwards; a lateral dark band on the posterior half of the trunk and on the tail; a cross band on the sides and lower edge of the caudal peduncle; ventrals with interspaces between inner rays, third to fifth, dark, while in *y-græcum* the ventral fins are uniformly whitish.

There is a remarkable difference between the young and old; some up to a length of nearly or quite three inches are scaleless.

[1] Since the above paragraphs were written Dr. Ulric Dahlgren, of Princeton, has visited the coast for the purpose of observing the Astroscope and has verified the electric power of the fish. A preliminary note has been published in *Science* (March 23, 1906, p. 469, 470) and details may be expected later.

In specimens of both *guttatus* and *y-græcum* two and one-fourth to three inches long, the skin is scaleless, and the head above has an osseous casque extending close up to the nostrils and between the eyes. This was supposed to be characteristic of *Astroscopus* and that genus was originally based on such characters. As the fishes increase in size the slight naked space behind the nostrils becomes enlarged and the enlargement continues until the large naked areas characteristic of the adult *Upsilonophorus* are developed. The identity of the two genera was recognized by Gill as early as 1872, but the differences seemed to be so great that some elapsed before the identification was entirely accepted.

III

A third well-marked genus (*Kathetostoma*) is represented by a couple of species in warm American waters.

FIG. 119.—*Kathetostoma albigutta.* After Jordan and Evermann.

FIG. 120.—*Kathetostoma albigutta.* After Jordan and Evermann.

The *Cathetostomes* (*Kathetostoma*) have the branchial apertures limited above by membranes partly bridging the interspace between the opercles and shoulders; the skull above is completely ossified, the preopercles are armed with three or four acute plectroid spines directed downwards, as in the Uranoscopes, but there is no subopercular spine; there are a pair of free and acute spines, one to each shoulder, and a pair of acute spines pointed forwards on the pelvic bones; the nostrils are very small, the anterior subtubular, the posterior a pore-like opening; scales are wanting; the soft dorsal fin alone is developed; there is no intralabial filament. Two species of the genus are known as Americans, one (*K. albigutta*) from the Gulf of Mexico, and another (*K. averruncus*) from the

Pacific coast of Columbia. These have been referred to the genus *Kathetostoma,* typified by a New Zealand fish (*K. monopterygium*), but have not been directly compared with the typical species on account of the absence of specimens of the last in the U. S. National Museum, and they may prove to represent another genus.

IV

Another distinct genus—*Execestides*—is represented by a recently described small species—or small specimen—found at Garden Key, one of the Tortugas. It differs from *Kathetostoma* by the peculiar sculpture of the preopercles and their aliform angles, the large opercles, longer anal fin, and general appearance. The only species, *E. egregius,* is only known from small specimens, a little more than two inches (2.3) long, "taken by Doctor Thompson on the reef at Garden Key."

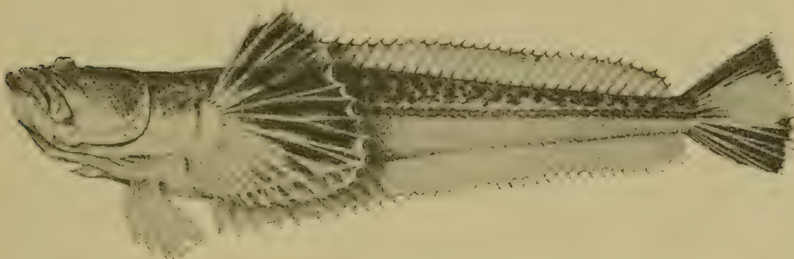

FIG. 121.—*Leptoscopus macropygus,* a distant relation of the Uranoscopids. After Richardson.

Although the Uranoscopids are so strongly marked a family, representatives of several others have assumed a nearly similar form. Besides the Leptoscopids and Dactyloscopids, which appear to be most closely related to them, species of unrelated families manifest some resemblance; such are the Batrachoidoid genus *Thalassophryne,* the Scorpænoid genus *Trachicephalus* (or *Polycaulus*), and the Trichodontoid genera.

III. THE WEEVERS

The Trachinids, or weevers, constitute another compact and strictly limited family readily recognized by their physiognomy. The body is rather elongated and quite regularly tapers from the pectoral region to the tail, the head is rhombiform inclining to cuboidal, is narrower than in the Uranoscopids, and the eyes are

mostly lateral, although somewhat directed upwards; the mouth is very oblique; the branchial apertures are continuous below, the branchiostegal membrane being very deeply cleft, only confluent in

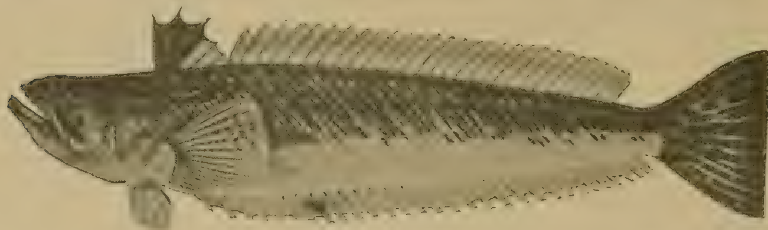

FIG. 122.—Greater weever (*Trachinus draco*). After Smitt.

front of the pelvis, and not bridged over by any fold; each operculum is armed above with a channeled spine directed backwards and connected with a special gland; the dorsal furniture is uniformly constituted by an anterior short fin with six or seven spines (the largest spines being channelled somewhat like the opercular ones), and a very long posterior rayed fin; the anal is also very long and the anus consequently in the breast; the pectoral fins have moderately wide but not procurrent bases, and the ventral are approximated, jugular, and have each a spine and five branched rays.

The range of variation within the family is much less than in the Uranoscopids or Batrachoidoids, the species so closely resembling each other that by all naturalists except one (Bleeker) they have been united in a single genus. Notwithstanding the superficial uniformity, however, some differences are manifest which are rarely developed in genera otherwise closely related; such are the differences in dentition and in the character of the lips. In the great weever (*Trachinus draco*) there are distinct pterygoid teeth, the lips are simple, and the cheeks and opercles scaly, while in the lesser weever (*Echiichthys vipera*) there are no pterygoid teeth, the lips are fimbriated, and the cheeks and opercles naked. Inasmuch as Smitt (1892) denies fimbriated lips ("lips without fringes") to the entire family Trachinidæ, this exception is especially noteworthy.[1]

[1] As the characters here given (and by Bleeker in 1861) are contradictory of statements given in highly esteemed European works, explanation may properly be demanded. According to Day (1880), *Trachinus vipera*, like *T. draco*, had teeth "villiform in jaws, vomer, ; alatines, and peterygoid bones." I have in vain searched the Lesser Weever for pterygoid teeth, as have also Prof. Gilbert and others. According to Smitt, all Trachinids have "lips without fringes" (p. 127), and this statement is uncontradicted in his notice

The family includes six or seven known species which have been generally retained in the single genus *Trachinus* but by others deemed to be referable to two or three genera. The distribution would be remarkable if real! All the described species are confined to the east Atlantic and Mediterranean coasts but one—and that one has been accredited to Chile. The so-called Chilian species (*Trachinus cornutus*), however, has not been found by Chilian ichthyologists and, in the "Catalogo de los Peces de Chile por Fedrico T. Delfin" (1901, p. 82), that as well as *T. draco* (the European greater weever) is retained as a Chilian fish solely on the authority of European authors.

Only two of the Trachinids are found in Northern Europe, the greater weever (*Trachinus draco*) and lesser weever (*Echiichthys vipera*). According to Boeke (1903), "both species are present in considerable abundance. The lesser weever is captured more often on the English coast (in the shrimp nets and sometimes in the trawl)"; the greater weever "especially on the Dutch coast, where they arrive in great numbers in summer to spawn, though here, too, the lesser weever is by no means rare. Both decrease in numbers towards the north." In the Baltic and further north only the greater weever occurs as a regular inhabitant although the lesser weever is admitted by Smith as an occasional or accidental visitor. "On the whole the lesser weever has a more southern distribution and lives in the shallow water near the shore and on sandbanks; the greater weever lives in deeper water."

All the species bear the English name weever, sometimes written weaver; this is by some claimed to be a derivative of the Anglo-Saxon word for a viper or serpent (wivere) and cognate with wivern, the dragon of heraldry, and by others to be a corruption of the French name for the fish (vive) or at least cognate with it. While weever is the best known and book name, however, it is not the only one. According to Day, the greater weever or stingfish is also known as the seacat (in Sussex), catfish, stingbull, and sand-eelbill (Ayrshire), while the little weever or stingfish is distinguished as the adder-pike, otter-pike, bishop, blackfin, and stony cobbler.

The weevers are essentially bottom fishes and affect sandy coasts specifically. According to Smith, "the greater weever lives in

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of the "*Trachinus vipera*" (p. 131); it is contradicted by Day (I, 82) who attributes to the species "a row of small papillæ along the upper edge of the lower lip." Papillæ are developed along the upper as well as the lower lip so large as to be readily discernible by the naked eye (of some persons at least).

water of a moderate depth with a sandy bottom. It buries itself in the sand and keeps in hiding in order more suddenly to attack its prey, which consists of small fishes and crustaceans." The hiding habit, however, appears to be sometimes deviated from; according to Day (1880), "in the Westminster aquarium these fish do not show any propensity to conceal themselves under the sand." Besides, it is not always the dorsal surface that is uppermost. According to A. Briot (1903), one of their favorite attitudes in the aquarium is repose on their sides with the outer opercle upraised and the spine nearly vertical. Perhaps in both cases the sand in the aquariums may have been too compact or otherwise unsuitable. The lesser weever is universally conceded to mostly hide itself in the sand, leaving little more than the eyes and parts on the same level exposed.

As to swimming, according to R. Schmidtlein (1879), weevers do not show much more endurance than their relatives, the star-gazers. Their movements are to be sure more active and, on account of the flexibility of the body, may almost be called winding, yet one falls to the bottom almost as awkwardly as the other, as soon as the muscles are at rest.

Sometimes, Schmidtlein also says, one puffs itself up for a few seconds while buried, opening wide the mouth and gill-covers and bristling the fins as if attacked by convulsive cramps. In many other fishes we frequently see the same kind of action which might by suggestively designated as yawning.

They are quite hardy and tenacious of life, and may easily survive being left during the recession of the tides on or in the sand. "In this situation of concealment," according to Couch, one "may chance to be left by the ebbing tide; but it is highly retentive of life, even when caught with a net or line, and therefore it suffers nothing by being left thus exposed." It may, however, work its way farther into the sand and become entirely concealed; Couch was informed of an instance where a dog, by pawing its way into the sand, showed its sense of some unwonted object that was concealed below, which, when discovered by digging, inflicted a blow on two persons who endeavored to grasp it, to their no little surprise and pain."

The weevers, or at least the greater weever, seem to be most active and prone to excursions in the night time; evidence to that effect was obtained by Jonathan Couch. He had known this fish taken in a floating net over thirty-five fathoms of water, and when several have been thus caught, it has always been in the early morning cast

of the nets, as if they thus mounted aloft only in the darkness of the night. A fisherman expressed the belief that he had even seen this fish spring above the surface." It remains to be ascertained whether such excursions are habitual or confined to breeding fishes.

Schmidtlein contrasted the habits of the weever with those of the stargazers. Most closely connected with the latter are the species of Trachinids, both as regards biology and relationship. But the slenderer and more elongated body of the latter, with the abrupt flanks and the crest-like back, indicates more active creatures. Mouth and eyes are directed upwards; but the latter occupy a somewhat lateral position, are extremely mobile, having complete independence of both axes, and show a brilliant blue or bluish-green metallic luster. Schmidtlein had repeatedly noted, among fishes, a vivid curiosity regarding lustrous and strikingly colored objects, and urged, for instance, that the black eyes of the "Langouste" (*Palinurus*) and other craw-fishes frequently expose them to danger. He was led to the opinion that the brilliantly lustrous and mobile eyes of Trachinids may serve to lure fishes. They are at least the most conspicuous part of the little that may be seen of the creature buried after the manner of the stargazer.

In the aquarium, according to Schmidtlein, the weevers are much more active than the stargazers. If fishes are thrown into one's basin, they start up immediately from the bed and snatch them up as they fall. However, an American Uranoscopid (*Astroscopus y-græcum*) may do the same.

The weevers have been regarded as mainly piscivorous, and doubtless accept any small fishes that may come within reach, but later observations show that they feed largely on crustaceans. Couch (1863) actually found in the stomach of one "two gobies and a launce," and in others various small fishes as well as squids and macrurous crustaceans (shrimps, etc.) had been found. But the most satisfactory data were obtained by Dr. T. Wemyss Fulton and published in the "Twentieth Annual Report of the Fishery Board of Scotland" (part III, p. 493, 1902). He examined forty-three specimens of the lesser weever with interesting results. "In the stomachs of those collected in April, 1900, very little food was observed, and only four out of the fourteen examined contained matter that could be identified; this consisted chiefly of the remains of *Praunus inermis* [a kind of prawn], *Gammarus locusta* [sand flea], some remains of annelids and of two or three small fishes (Clupeoids). . . . In the stomachs of ten specimens examined in May the contents consisted chiefly of *Schistomysis* sp. [a schizo-

pod]; an isopod—*Eurydice achata*—was also found in one, and in another the remains of a small Clupeoid. The specimens taken in September and January contained nothing that could be distinguished. The nine specimens from Collieston collected on July 5, 1900, had apparently been feeding largely on Schizopods, all of which appeared to belong to the one species, *Schistomysis spiritus;* the only other food observed consisted of the remains of a small fish, probably a young Clupeoid or sand-eel. . . . A considerable number of these specimens were examined besides the nine specially referred to here, but they all appeared to have been feeding on the same species of Schizopod."

According to Schmidtlein, a weever possesses, in the erectile spines of the dorsal, a weapon not to be despised; these spines are as stiff and pointed as needles, and are bristled up on the least disturbance of the fish. The edge of each opercle is also armed with a similar spine, the punctures of which are generally considered poisonous, wherefore the fishermen handle the otherwise valued fishes with great caution.

The opercular spines are not merely defensive but efficient offensive weapons, for they can be actively struck in some desired direction. Jonathan Couch (1863) aptly remarked that "the precision and skill with which the formidable spine of the" opercle, "is thus directed to an object of fear that shall touch it or approach too closely are indeed surprising, so that by a sudden and rapid impulse it will inflict a wound if even the touch is confined to the tail, and that too, without any injury to itself: and formidable indeed is the effect produced by the puncture."

The extent to which the weevers use their spines against other fishes is unknown. The fishermen of old apparently thought they were very aggressive and impressed the other fishes by the fact, if we may believe Ovid, who sang of the

> "Weevers, whose march the timorous shoals obey,
> Divide their ranks, and humbly give the way."

This, however, is undoubtedly "poetical license." It is, however, certain that wounds inflicted by the opercular spines of weevers upon fishes and batrachians may result in speedy death as was proved by the experiments of L. Gressin (1884) and A. Briot (1903).

There appears to be considerable difference between the effects of wounds made by the dorsal and opercular spines. According to A. Briot (1903) wounds inflicted by the dorsal spines, although

very painful for a time on account of the acuteness of the spines, are of a mechanical nature and are not followed by any aggravated symptoms. The same experimentalist found that wounds resulting from punctures with an opercular spine, while equally or more painful, were followed by more serious consequences, such as fever, shivering, and, in extreme cases, œdema and gangrene. Briot was led to such conclusions by experiments made on animals (sticklebacks, toads and rabbits) as well as observation of wounds incurred by fishermen. The record of his investigations may be found in the Comptes rendus hebdomadaires des seances de la Société de Biologie (LV, pp. 623–624).

The experimental observations of Briot are not inconsistent with the histological investigations of L. Gressin and W. N. Parker (1888). Those observers, it is true, found venomiferous glands connected with dorsal spines of weevers as well as with their opercular ones but the former were much less developed and the spines themselves less formidable than the corresponding parts of the opercular apparatus. In the words of Parker, " distinct glands are present in the grooves of the opercular and dorsal spines, and in the former they are very large, extending a considerable distance both above and below the spine, along the greater part of its length. The glands consist of relatively enormous granular nucleated cells, the structure of which is apparently similar in both species " of northern weevers.

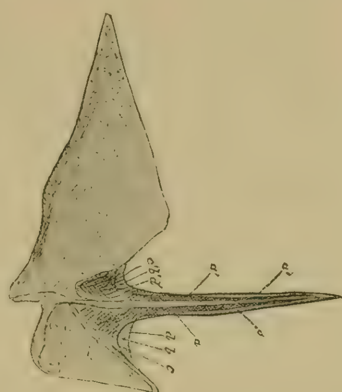

FIG. 123.—Lesser weever's operculum. Right opercular spine with the sheath removed, viewed upon the external surface, and magnified about five times in linear extent. *a, a, a′, a′,* The grooves in the edges of the spines; *b, b′,* the conical cavities in which the grooves terminate; *c, c′,* the external walls of the cavities; *d, d′,* the internal walls. The parieties of the cavities being transparent, *d′* is represented as visible through the external wall. After Allman.

It is remarkable that the poison glands were long denied existence by observers and histologists. For example, Cuvier and Valenciennes (1829) specifically asserted that the spines had none. " :n'ayant aucun canal, ne communiquant avec aucune glande, elles ne peuvent verser dans les plaies un venin proprement dit." G. J. Allman (1841) was also "not able to detect any specific gland connected

with" the opercular spines, although he was led "to agree with the ancients in ascribing venomous properties to the weever." The first to demonstrate the existence of poison glands in the weevers was Leon Gressin in association with A. M. Remy (1884). He was followed by W. N. Parker (1888) who expressed, quite properly, "much regret" that he had been "unable to obtain a copy" of Gressin's thesis.

There is essential agreement between the observations and illustrations of Gressin and Parker. In the words of the latter, "distinct glands are present in the grooves of the opercular and dorsal spines, and in the former they are very large, extending a considerable distance both above and below the spine, along the greater part of its length. The glands consist of relatively enormous granular nucleated cells, the structure of which is apparently similar in both species." "No special muscles are present in connection with the glands" and Parker "inclined to think that in the discharge of their secretion the cells simply burst, their contents passing along the grooves amongst the other cells to the exterior."

The males and females have not yet been observed in the act of oviposition and fecundation. "The eggs are laid in the night," and presumably "in the very early hours of the morning, just before or after daybreak," but Brook sought in vain to discover the exact time; he "watched the fish up to 1 A. M., and resumed watch as early as 5 A. M.," but was never "able to catch them in the act of ovipositing." In the early morning, however, eggs may appear on the surface of the water, bouyed up by greenish-yellow globules, and already visibly on the way to development. This oviposition occurs from April to July in northern seas.

The embryology of two species of Trachinids is partially known through the labors of a number of naturalists, beginning with Brook in 1884, and both species were studied by Boeke in 1903, who succeeded in fertilizing the eggs and thus studying perfectly authenticated examples. The eggs of the two are readily distinguishable, those of the larger fish averaging smaller and having normally only a single oil-globule, while the eggs of the smaller fish are mostly larger and have four to twenty-five oil globules.

The eggs of the lesser weever have a diameter varying between 1.04 and 1.27 or even 1.37 of a millimeter in diameter; they are "of a beautiful pearly white, and quite translucent." Each contains a variable number of oil-globules, ranging from four up to as many as thirty, Raffaele finding the smaller number, George Brook the larger (11–30). "These oil-globules," according to Brook "are

scattered over the upper hemisphere of the yolk, and lie between it and the vitelline membrane. They vary in size from .12 to .03 millim. The oil-globules cause the egg to float with the germinal disk downwards, so that the embryo is developed on its back, so to speak, and it is not till some time after hatching that the young fish is enabled to swin with the ventral surface downwards."

In a very few hours after extrusion the fertilized eggs show the evidence of segmentation. About 9 o'clock (A. M.) "the first two cells are formed." Development rapidly goes on and sometimes as early as the eighth day after emission, and thence to the eleventh day (the time depends on the temperature), the young are hatched out and begin life as free larvæ.

A "recent hatched larva," according to E. W. Holt, M'Intosh and Masterman, is nearly a seventh of an inch ("3.27 mm.") long and, with its prominent yolk, reminds one of a tadpole. The mouth is "only indicated by a slight depression in the newly hatched embryo."

The eggs of the greater weever have a diameter of from less than a millimeter (0.96) to considerably more (1.11) and only a single large oil-globule; they are "perfectly transparent." At "about 120 hours after fertilization (temperature of the water ranging from 15° to 70° C.) the embryos were hatched" and with a slight increase of temperature the hatching was accelerated to 110 hours.

According to Boeke, "immediately after hatching the buoyancy of the yolk-sac causes the little larvæ to float helplessly in the water, the yolk-sac uppermost, but very soon they are able to keep themselves in the normal position and swim about actively when disturbed. At rest they hang with the front end inclined downwards, as is also the habit in other very young fishes under these conditions. The oil-globule has now taken a position at the foremost part of the yolk-sac. The larvæ are still perfectly transparent, and but for the strongly marked black spots are difficult to see. . . . At about four or five days after hatching the yolk has almost entirely disappeared and the larvæ die." Consequently neither Boeke nor others have succeeded in tracing the early post-larval history of the species.

A kind of homœopathic remedy is resorted to by some to avert the evil effects of wounds inflicted by a weever. "In Bohuslän, says Fries, it is held to be a sovereign remedy to cut open the belly of the fish that has caused the wound, take out the liver and at once make the patient eat it. This remedy, strange as it may appear," adds Smitt, "is never omitted"! An analogous antidote was also found in the fish's brain. In the words of A. Saville Kent (1883)

"in ancient days a so-called 'tisane,' thickened with the brains of the offending fish or the body of the fish itself cut open and applied to the wound, were reckoned among the more effective remedies." Even the boys in some parts of the country, however, know better. "At Fredrikshavn, it is a favorite pastime of the boys to fish for weevers in the harbor, and when they go fishing, they take with them a bottle of hartshorn or, still more commonly, of aquafortis, which they apply to the wound immediately, if they are stung by a weever."

Various myths have originated about the weevers and one prevalent for centuries (it is recorded by Willughby) and widespread in the British Islands is that "the pain of its sting will last until the tide has again arrived at the height at which it stood when the wound was inflicted." This opinion, Allman thought it not unnecessary to declare, "is altogether incorrect," although it "is universally believed by the fishermen of the south of Ireland." Allman adds that the weevers and "some other spiny fishes" are "confounded under a common unpronounceable Irish name, which may, I believe, be translated 'sting devil.'"

The weevers are market fishes to a greater or less extent. Smitt records that the flesh of the greater weever "is said to be of excellent flavour," but, nevertheless, on account of its dangerous spines, in Sweden "it is generally thrown away by the fishermen." According to Moreau, in France the flesh of the larger kinds is very highly esteemed. In some countries there are laws prohibiting the marketing of weevers unless their opercula and spinous dorsals are cut off.

APPENDIX

ON CERTAIN HABITS OF THE EUROPEAN STARGAZER

By LUIGI FACCIOLA

Dr. Luigi Facciola, in a long article on some organic characteristics of *Uranoscopus scaber* having relation to its hiding instinct,[1] has given some interesting details of the habits of that species. After a few references to previous observers (Oppian, Rondelet, Martens), the peculiar form of its stomach (subrotund), and contents found in it ("*Atherina hepsetus, Engraulis enchrasicholus,*

[1] Di alcune disposizione organiche dell' *Uranoscopus scaber* in rapporti al suo istinto insidiatore nota dell Dott. Luigi Facciola. Atti Soc. Nat. Modena, Ser. III, Vol. I (anno 16), pp. 17–28, 1883.

Alosa sardina"), reference is made to the spines at the front of the pelvis and the flatness of the belly which are believed to especially fit the fish for penetrating into the sand. The form and sculpture of the head and the color of the eyes are adapted to assimilation to its environments and concealment. The vermiform extension of the intralabial valve serves as a bait. How these structures were used was the subject of speculation. Now Dr. Facciola may speak for himself (pp. 22–28).

At this time I fortunately had a live individual. It stayed at the bottom of the basin, keeping the pectoral and ventral fins spread out, while the others were lowered. The mouth was opened to the extent of scarcely two millimeters, and the opercles were closed. The lower jaw moved very slightly backwards and forwards, the extension not amounting to more than one millimeter. But inside the mouth and within the jaw was seen a more energetic movement, like that of a kind of valve which was raised and lowered; this belonged to the transverse membrane which is attached to the inner border of the lower jaw and gives rise at the middle to a linguiform extension.[1] This participated in the movement and inclined to project out of the mouth. Thus there seemed to me to be no doubt that the sublingual membrane assumed the functions of the lower jaw which moved almost insensibly. I held the lower jaw apart by means of a pair of pincers to see what would happen under the circumstances. Then the sublingual membrane stopped beating and the hyoid was raised and lowered, but so regularly as to suggest that these movements were excited by the exceptional state in which the fish was placed through the forced abduction of the lower jaw. When the fish was free again, and I observed more carefully the movements of the transverse membrane, I became convinced that these movements were passive ones and produced by a quantity of water that comes between the membrane and the underlying hyoid and were impelled by the action of the latter bone. This easily explained the inertness of the membrane when the mouth was held open, the reason being that under the circumstances the hyoid is moved backwards and its upper border no longer corresponds to the lower part of the membrane. It is to be noted that the tongue does not advance much in front of the hyoid and forms with the latter a single border regularly convex and corresponding with the form and disposition of the transverse

[1] This membrane was well described by Rondelet, questioned by Willughby, and again confirmed by Cuvier and Valenciennes.—Facciola.

membrane. There were counted about forty acts of respiration in the first minutes, or the twofold movements of raising and lowering of the hyoid. But it now remains to account for the permanent closure of the opercles. The fish, meanwhile, being in the vessel, beat from time to time the pectoral and ventral fins, as though it sought to lie down flat.

I therefore placed some fine sea sand and water into a large receptacle, into which I put the fish. On feeling the sand with the paired fins (for its eyes could not see it) the fish buried itself in it by means of lateral movements of the tail aided by the paired fins, leaving in sight only the eyes and the upper portion of the mouth opening which formed a narrow and elongated cleft in the even sand layer. Farther back, toward the posterior part of the head, two round holes were visible on the sand, of which I shall speak shortly.

In this position, the lower jaw, of which only the extreme edge protruded, remained completely motionless, and the slight movements which we noted while the fish was in the midst of the water, and which were passive, had been stopped by the obstacle furnished by the sand which is not so easily displaced as the former element. Moreover, it follows that the jaw cannot move without the fine sand-grains, which cover it to its edge, falling into it. The jaw might move slightly in the direction of closure against the upper jaw, but the act of approaching would not have been followed by a withdrawal or return to the original position, because the sand would push itself more and more against the jaw and finish by closing it completely. This same jaw is so little open that its fringe almost touches the upper lip, thus preventing the entrance of foreign bodies into the mouth, such as small crustaceans, which pass over the surface of the bottom and which the fish could not in any way keep off. Besides, as we have seen, it is necessary that the mouth should be slightly open to accomplish respiration. The sublingual membrane beat more slowly than when the fish was in the midst of the water. As soon as it buried itself in the sand, respiration stopped for a moment. Moreover, the fish entered the sand with the mouth shut, and on opening it on the surface of the bottom, the small quantity of sand which covered the mouth, fell into it and was then expelled again through the branchial apertures. The eyes, which were almost on a level with the horizontal surface of the head, would remain buried, if the fish did not previously sink them into their cavities by raising the suborbital; in fact, the fish makes them protrude above the surface of the sand by lowering

that bone. It has been stated that the eyes are favorably placed for discovering prey; we may add that if they were lateral the head could not bury itself very far into the sand without impeding the vision. It is also useful that the surface of the head is horizontal, because in this way it is likewise covered by the sand. If the opercles do not beat when the fish is surrounded by water, they close the branchial apertures still more effectually in the sand. Now at the place where the two apertures project behind the head, there forms immediately a little vortex of sand which is thrown up by the water; little by little the sand-grains are deposited around it and the hole is formed without a single grain stirring afterwards. At the bottom of the hole may be seen a constant rising and lowering of a whitish body which is none other than the upper end of the branchiostegal membrane. This end is soft, spongy and discoidal, and is attached to the scapula a little below the spine which is a posterior lengthening of the latter bone. It is solely from this point, or the upper angle of the branchial aperture, that the water finds an egress, because a doubling of the skin which prolongs posteriorly the border of the operculum permanently closes the aperture. In other fishes the branchiostegal membrane is often seen to project to a great extent below and also a little backwards beyond the border of the parts closing the branchial aperture, and in the latter place this membrane supplies that which the opercle lacks in closing the corresponding portion of the aperture.

In *Uranoscopus,* on the other hand, the upper border of the branchiostegal membrane does not project outside the edge of the opercle, because the latter, as has been stated, is enlarged by a membranous portion. Cuvier and Valenciennes[1] noted this peculiarity in the following words: "The borders of the opercular valve are enlarged by a portion of the skin which adds a large band to them." This skin portion is thick and notched in the margin, and covers pretty well over the scapular region. Also the free margin of the opercle is furnished with a portion of the skin, but narrower than that of the opercle. It is easy to explain the utility of these dispositions. The branchiostegal membrane is constantly agitated to throw out the water admitted by respiration. These movements would be impossible while the fish remained buried in the sand, if the opercles were not adapted in such a manner as to oppose the obstacle which the sand placed in their way. As a matter of fact, the opercles are somewhat hollowed, and thus permit the branchiostegal membrane to move freely within. The membranous por-

[1] Hist. Nat. d. Poissons, III, p. 292.

tion of the opercular valve closes the branchial aperture, thus forcing the water out at its upper angle, as from a kind of vent. This is also the place where the water is ejected when the fish is swimming free in the midst of that element.

The fish remained all night in the same position in which I had left it the day before. . . . On the following day I had it taken out, and touching its belly I found the stomach to be empty; I therefore supposed the fish to be very hungry. Having a few live specimens of *Gobius niger* I placed them near the *Uranoscopus* which had again buried itself in the sand. The *Gobius* passed over the head of the fish and stayed there, but the *Uranoscopus* would not take hold of one, either because it was so much annoyed, or because such fishes were not is natural prey.

It may be concluded from what has been said that the *Uranoscopus* is adapted for a life hidden in the sand or mud. I do not doubt that this habit is designed to procure its food for it. If it were a means of defence, the offensive weapons with which nature has provided the fish and which are of the most redoubtable kind would be almost superfluous. As the fish does not appear from its original organization to be a very agile swimmer, and especially from the weight of its head, those weapons will assist it when moving about in the water, either to change its place or to approach the female. The shape of its mouth will not permit it to lay hold of its prey in any other way than the insidious one which was already spoken of. I am assured by the fishermen that this fish is never taken with a line, but with a spear or sometimes in a net. As a matter of fact, it is nearly always seen in the market injured. The young of this species hunt smaller fishes according to the capacity of the stomach; and these latter fishes again pursue very small creatures, and thus there is an agreement between the instinct of the prey and that of the enemy.

In the stomach of a *Uranoscopus* more fishes are generally found; this shows that when it has obtained some prey, it continues its insidious manœuver, until its belly is filled. The abdominal cavity has an enormous gall-bladder, while in other fishes which feed exclusively on fish, that organ is of ordinary size. But in *Uranoscopus* a greater quantity of bile may be needed, because the fish is very voracious, and probably also because the flesh of the sardines, which are most frequently found in its stomach, is fatty.

It might be asked whether the various dispositions which render the fish adapted for staying buried in the ground, were established from the beginning, or whether they are the effect of adaptation.

To answer this we should have to go beyond the scope of this article. We shall only note a fact which gave occasion to put such a question. There are fishes in which the branchial aperture is very little open, as in the gobies; others in which it is reduced to a foramen or a kind of tube which opens posteriorly as in the eels. Therefore it would have been more reasonable and suitable to give to *Uranoscopus,* which does not beat the opercles in the water and cannot beat them buried in the sand, a conformation of the branchial aperture nearly similar to that of the eels. And in fact, if the branchial aperture appeared from the beginning as it is at present, then that would indicate that the hand from which it proceeded was not very wise, as it had sought to hinder that which it had first established; we refer to the skin portion which prolongs posteriorly the opercular valve and serves to close the branchial aperture in that place. We must, therefore, suppose this disposition to be the result of adaptation. But, it might then be asked, would it not have been more expedient if the branchial aperture had become restricted? The answer is, nature in her operations employs the most expeditious means to an end; it is easier, in fact, to enlarge the extension of a part than to establish continuity where there is an interruption.

These observations are printed here to call the attention of American observers to characteristics which will *not* be manifested by the American *Astroscopes.* As the latter have the opercles roofed over above and lack the intramandibular linguiform appendage, their habits must necessarily differ from those of the *Uranoscopes.* Their contrasting peculiarities should be the subject of early consideration. The details will show how much representatives of nearly allied genera may differ in their habits as well as the morphological characteristics which determine habits—or are the eventual outcome of differences of habits.

THE LETTER OF DR. DIEGO ALVAREZ CHANCA, DATED 1494, RELATING TO THE SECOND VOYAGE OF COLUMBUS TO AMERICA (BEING THE FIRST WRITTEN DOCUMENT ON THE NATURAL HISTORY, ETHNOGRAPHY, AND ETHNOLOGY OF AMERICA)

(Translated from Spanish original, as spoken and written in the fifteenth century, with explanatory notes, geographical and historical remarks.)[1]

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[This document is a letter addressed to the Municipal Council, or Cabildo,[2] of the city of Seville, Spain, by Dr. Diego Alvarez Chanca, a native of that city and physician to the fleet of Columbus on his second voyage of discovery to America,[3] dated at the port of Isa-

[1] A lecture delivered before the Biological Section of the New York Academy of Sciences, at the American Museum of Natural History, March 5, 1906.

This important historical document, written not by any means with the idea of specially treating of the flora, the fauna, the ethnology, and the anthropology of America, yet speaking familiarly about those subjects, was translated into English by Mr. R. H. Major, of the British Museum, and published in London for the Hakluyt Society in 1847; but as it was penned by its author in the old Spanish of the fifteenth century, its translation into English, by a foreigner of the nineteenth century, naturally contains several almost unavoidable inaccuracies, and lacks appreciation of the many fine and subtle meanings in phraseology, deviating from the rules of grammar, which the original letter possesses. Besides, Dr. Chanca was an Andalusian, who had all the ready wit and quick perception of the humorous side of events, combined with the hyperbolic way of expressing their thoughts, so peculiar to the natives of Southern Spain, and almost impossible to appreciate in their full significance by foreigners. All other publications of this document by the English and American press, have been, I believe, repetitions of Mr. Major's version.

[2] This is the name then given to the corporation of a town in all the Spanish dominions, equivalent to Chapter, after the chapter of a cathedral or collegiate church. It is now called the *Ayuntamiento,* and is composed of a Corregidor or Alcalde, and several Regidores; the first corresponding to Mayor, and the latter to Aldermen.

[3] This physician was a distinguished practitioner of much learning and professional skill, who held the position of Physician-in-Ordinary to the King and Queen of Castile and Aragon, and had attended their first-born

bella, in the island of Hispaniola, or Santo Domingo, West Indies, at the end of January, 1494. This letter left the port of Isabella on February 2d, in care of Don Antonio de Torres, commander of the twelve vessels sent back by Columbus to Spain with the news of the discoveries, and arrived there April 8, 1494. Every thing Dr. Chanca says in his letter, therefore, regarding those just discovered islands of the New World, he learned in the short space of time between November 3, 1493, when he saw the first island (Dominica), and the last week of January, 1494—that is, in less than three months.

Dr. Diego Alvarez Chanca had been especially appointed by the Spanish monarchs to accompany that expedition, not only on account of its great political and commercial importance, but also because among the 1,500 persons who came over from Europe to America in that fleet were several distinguished Court personages and a large number of young gentlemen belonging to aristocratic families, restless and daring warriors who had done excellent military service in the war just successfully ended against the Moors of Spain.

Mingling with the men of distinction who come over from Spain to America in that expedition I may mention the following: Juan Ponce de León, the future conqueror of Puerto Rico and later on the discoverer of Florida; Alonso de Ojeda, the future discoverer and explorer of the north coast of South America, with whom the Italian Amerigo Vespucci made his first trip to the New World, named after him; Pedro Margarit, the subsequent discoverer of the archipelago to which he gave the name of the Marguerite Isles; Juan de la Cosa, the expert cosmographer, author of the first map of America in existence, drawn by him in the year 1500 and now in the Royal Naval Museum at Madrid;[1] Antonio de Torres, a brother of the nurse (*aya*) of Prince Juan; the father and the uncle of Fray Bartolomé de las Casas, the accomplished Spanish historiographer of America; Bernal Diaz de Pisa, the accountant or treasury official

child, Princess Isabella (who afterward became Queen of Portugal) during a serious illness the year before. On his return to Spain, Dr. Chanca published in Spanish, in the year 1506, a treatise on The Treatment of Pleurisy (Para curar el mal de costado), and a commentatorial work in Latin, criticising the book entitled "De conservanda juventute et retardanda senectute," whose author was another eminent Spanish physician named Dr. Arnaldo de Villanova. The title of this second work of Dr. Chanca is "Comentum novum in parabolis divi Arnaldi de Villanova," which was printed in Seville in the year 1514.

[1] See the accompanying illustration, which shows the American portion of that unique map.

of the expedition; Diego Marquez, the overseer of the flotilla and master of one of the caravels; Villacorta, a noted mechanical engineer; Fermín Zedo, an expert metallurgist; Francisco de Peñalosa; Ginés de Gorbalán; Juan de Rojas; Alonso de Valencia; Sebastian de Olano; Juan Aguado; Gaspar Beltrám; Juan de la Vega; Pedro Navarro, and Melchor Maldonado. Other equally distinguished persons who came over in the second voyage of Columbus to America, were: Fray Bernal Boil, apostolic delegate of Pope Alexander VI, accompanied by twelve fathers belonging to different religious orders, among whom the most prominent were Fray Román Pane, Fray Juan de Tisín, and Fray Juan de la Duela, familiarly called *el Bermejo*, on account of his red hair.

As an able practitioner of medicine, Dr. Chanca showed his skill by saving the life of Christopher Columbus, who suffered a very dangerous attack of typhus fever, on one occasion, and pernicious malarial fever, on another occasion, as well as the lives of many Spanish hidalgos who were at the point of death, as victims of disease, during their stay at the island of Hispaniola, the Santo Domingo of to-day, called at that epoch Haití by the aboriginal inhabitants.

This expedition of the Spaniards was altogether different from the one sent out the previous year in quest of a new passage to the Indies. Instead of three caravels, carrying only 120 persons, which accomplished the discovery of the Western Hemisphere, this flotilla was composed of three great galleons or carracks and fourteen caravels of different sizes. It was well provided with the requisites for the establishment of a permanent settlement in the land that had been discovered the year before. Even 20 horses for as many soldiers armed with lances, which played a most terrorizing influence among the American Indians,—because they had never seen horses before, and supposed that both the animal and his rider were a single individual—came over also on board those Spanish vessels.

Besides this excellent description of the first part of the second voyage of Columbus to America, which competent authorities consider the best in existence, Dr. Chanca also supplied information to Father Andrés Bernaldez, the celebrated parish priest of the town of Los Palacios and chaplain to the archbishop of Seville, Don Diego de Deza, which enabled Bernaldez to give many important details of this expedition of the Spaniards in his famous historical work entitled "Chronicle of the Catholic Kings." The town of Los Palacios is located twelve miles to the south from the city of Seville, and has at present a population of about 2,000.]

AMERICAN PORTION OF LA COSA MAP, 1500. ORIGINAL IN ROYAL NAVAL MUSEUM, MADRID, SPAIN

Here follows the letter:

"Since the occurrences which I relate in private letters to other persons are not of such general interest as those which are contained in this epistle, I have resolved to give you a complete narrative of the events of our voyage, as well as to treat of the other matters which form the subject of my petition to you.

"The expedition which their Catholic Majesties sent, by divine permission, from Spain to the Indies under the command of Christopher Columbus, admiral of the ocean, left Cadiz on the 25th. day of September, in the year 1493, with wind and weather favorable for the voyage. This wind lasted two days, during which time we managed to make nearly fifty leagues. The weather then changing, we made little or no progress for the next two days; it pleased God, however, after this, to restore us fine weather, so that in two days more we reached the island of Great Canary. Here we put into harbor, which we were obliged to do to repair one of the ships that made a great deal of water. We remained all that day, and on the following set sail again, but were several times becalmed, so that four or five days more passed before we reached the island of Gomera. We had to remain at Gomera one day to lay in our stores of meat, wood, and as much water to drink as we could stow, preparatory for the long voyage that we expected to make without seeing land.[1] Thus it happened that through the delay at these two ports, and being calmed the day after leaving Gomera, we spent nineteen or twenty days before we arrived at the island of Ferro.[2] After this we had, by the goodness of God, a return to fine weather, more continuous than any fleet ever enjoyed during so long a voyage; so that leaving Ferro on the thirteenth day of October, within twenty days we came in sight of land, but we should have seen it in fourteen or fifteen days if the ship *Capitana*[3]

[1] From the island of Gomera Columbus embarked eight pigs, bulls, cows and calves, sheep and goats, fowls and pigeons, seeds of oranges, lemons, bergamots, citrons, pomegranates, dates, grapes, olives, melons, and other European fruits, as well as all kinds of orchard and garden vegetables. All these things were the origin of their species in the New World. The expedition likewise carried twenty horses belonging to twenty soldiers armed with lances, shipped before leaving Cadiz; besides stores of all kinds, including medical and surgical supplies, and implements of husbandry, from Spain.

[2] The southwesternmost of the group of the Canary Islands, and named Hierro in Spanish. Formerly this group was called the Fortunate Islands.

[3] A galleon (known in Spain as a nao, like the *Santa Maria* of the first voyage) of four hundred tons burden, that carried the Admiral's flag, and in which the writer of this historical document made the trip. Columbus's younger brother Diego, and three old comrades of his first voyage to America, were also on board this vessel.

had been as good a sailer as the other vessels,[1] for many times the others had to shorten sail because they were leaving us much behind. During all this time we had great fortune, for throughout the voyage we encountered no storm, with the exception of one on St. Simon's eve, which for four hours put us in considerable danger.[2]

"On the first Sunday after All Saints' day, namely, the 3d. of November, about dawn, a pilot of the ship *Capitana* cried out: 'The reward, I see land!'[3]

"The joy of the people was so great, that it was wonderful to hear their cries and exclamations of pleasure; and they had good reason to be delighted, for they had become so wearied of bad living, and of working the water out of the leaky ships, that all sighed most anxiously for land. The pilots of the fleet reckoned on that day that between the time of leaving the island of Ferro and first reaching land we had made eight hundred leagues;[4] others said seven hundred and eighty, so that the difference was not great, and three hundred more between Ferro and Cadiz, made in all eleven hundred leagues.[5] I do not, therefore, feel now as one who had not seen enough water.

"On the morning of the aforesaid Sunday we saw lying before us an island, and soon on the right hand another appeared: the first[6] was high and mountainous on the side nearest to us; the other was flat and very thickly wooded.[7] As soon as the light of day became brighter other islands began to appear on the right and on the left of us, so that that day there were six of them to be seen lying in different directions, and most of them of considerable size.

[1] Sixteen in number.

[2] They believed themselves in much peril that evening, October 27, as they certainly were in such a sudden and fierce storm, accompanied by heavy rain, rapid lightning and loud peals of thunder, so frequent in the tropics—until they beheld several of those lambent flames called by sailors "St. Elmo's tapers," playing about the tops of the masts, and gliding along the rigging, which are occasionally seen about tempest-tossed vessels during a highly electrical state of the atmosphere. The sailors consider that phenomenon as of good omen.

[3] The Spanish government had offered a reward in money to the first person who should see land on this voyage, the same as had been done on the first voyage of discovery to America.

[4] That is, 2,400 Spanish miles, or about 2,057 English miles.

[5] 3,300 Spanish miles, or about 2,829 English miles.

[6] This was Dominica, so called by Columbus from having been discovered on a Sunday (Dies Dominica). It is 29 miles long and 13 miles in its greatest breadth, has an area of 291 square miles, and belongs to England.

[7] The island to which Columbus gave the name Marigalante, the real name of the galleon *Capitana,* in which he and Dr. Chanca sailed. It has an estimated area of 60 square miles, and belongs to France.

GUADALOUPE, MARIE GALANTE, AND DOMINICA.
[From Henrique's *Les Colonies Françoises*, Paris, 1889.]
FIG. 124.

"We directed our course towards that which we had first seen, and, reaching the coast, we proceeded more than a league in search of a port where we might anchor, but without finding one: all that part of the island which met our view appeared mountainous, very beautiful, and green even down to the water's edge. It was delight-

ful to see it, for at that season of the year there is scarcely any thing green in our country. When we found that there was no harbor on that side[1] the admiral decided that we should go to the other island, which lay on our right, and was about four or five leagues distant.[2] One of the vessels, however, still remained at the first island all that day seeking a harbor, in case it should be necessary to return thither. At last, having found a good one where they saw both people and dwellings,[3] they returned that night to the fleet, that had already put into harbor at the other island; and there the admiral, accompanied by a large number of men, landed with the royal banner unfurled in his hands, and took possession of all that territory we had discovered on behalf of their Majesties.

"This island of Marigalante is filled with an astonishing thick growth of wood; that variety of trees being unknown to us, some of them bearing fruit and some others flowers. It was surprising to see that, and indeed every spot was covered with verdure.

"We found there a tree whose leaf had the finest smell of cloves that I have ever met with; it was in shape like a laurel leaf, but not so large: I think it was really a species of laurel. There were wild fruits of various kinds, some of which our men, not very prudently, tasted; and upon only touching them with their tongues, their mouths and cheeks became swollen, and they suffered such a great heat and pain that they seemed by their actions as if they were crazy, and felt obliged to resort to cooling applications to ease the pain and the discomfort.

"We found no signs of any people living in this island, and concluded it was uninhabited. We remained there two long hours for it was already near evening when we landed, and on the following morning we left for another very large island, situated below this one and at the distance of about seven or eight leagues.[4] We approached it under the side of a great mountain that seemed almost to reach the skies, in the middle of which rose a peak higher than all the rest of the mountains near it, and from which many streams came out and diverged into different channels, especially towards that part to which we were proceeding. At about three leagues' distance from it, we could see an immense fall of water that appeared to us of the breadth of an ox, and came rolling down from

[1] Dominica has no harbors, but there are several good roadsteads on its western side.

[2] The island Marigalante, as already stated.

[3] Probably the beautiful anchorage at the north end of the western coast of Dominica, now called Prince Rupert's Bay.

[4] Known to-day as Guadeloupe, which belongs to France.

such a height that it looked as if it were falling from the sky. It could be seen from that great distance, and it occasioned many wagers to be laid on board the ships, some people saying that it was nothing else but a series of white rocks, while others maintained that it was a great volume of falling water. When we came nearer, it showed itself distinctly: it was the most beautiful thing in the world to see how from so great a height, and from so small a space, such a large fall of water was being discharged.[1]

"As soon as we approached the island, the admiral ordered a light caravel[2] to run along the coast to search for a harbor. The captain of this small vessel put into land in a boat, and seeing some houses leapt on shore and went up to them, the inhabitants fleeing at sight of our men. He then entered the houses and found therein various household articles that had been left unremoved,[3] from among which he took two 'parrots,' very large and quite different from the parrots we had before seen.[4] He found also a great quan-

[1] Unquestionably, it was water that this culminating peak was throwing out. Neither Dr. Chanca, Columbus, nor any of their companions on this voyage speak of having seen a volcano on the island of Guadeloupe, and for this reason I am inclined to the opinion that the volcano La Souffrière of this island (for there is another with the same name on the island of St. Vincent) did not exist at the time of the discovery, but that some seismic convulsion occurred afterward that transformed that "great mountain that seemed almost to reach the skies" into a regular volcano. The fact that there are now three extinct volcanoes on that island seems to lend force to my way of thinking in regard to the subject. In Central America there is a volcano that pours forth water instead of lava or ashes.

[2] The fleet of Columbus, on this his second voyage of discovery, consisted of three galleons or carracks and fourteen caravels of different sizes, carrying a total of 1,500 persons, among whom were several distinguished personages and a large number of aristocratic young fellows anxious for adventure after their exploits in the war against the Moors had ended. On the first voyage only 120 persons accompanied Columbus, 38 of whom remained at the port of La Navidad in the island of Hispaniola or Santo Domingo when Columbus returned to Spain, arriving at the same little port of Palos from where he had started 225 days before. A wonderful achievement!

[3] Among these household articles were netted hammocks, utensils of earthen pottery, what seemed to be an iron pot, and the stern post of a European ship. Several receptacles of different sizes and shapes, for various uses, called by the Indians jícaras, were also found. They were made from a melon-like fruit called Güira, in Spanish, and in English, Calabash-tree, of which there are two species, the *Crescentia cujete* and the *Crescentia cucurbitina;* cups, hollow dishes, bottles, etc., were then, and are still, made of this fruit, which is never eaten, but with the soft pulp of its inner part there is prepared a pectoral syrup which is a common household remedy in all the Spanish Antilles.

[4] These were not real parrots, but as the author himself says in his letter, papagayos, that is, macaws with a short tail, or popinjays.

tity of cotton, both spun and already prepared for spinning, and provisions of food, of all of which he brought along with him a portion. Besides those articles of food he likewise brought away with him four or five bones of human arms and legs. When we saw those bones we immediately suspected that we were then among the Caribbee islands, whose inhabitants eat human flesh, because the admiral, guided by the information respecting their situation he had received from the Indians of the islands he had discovered during his former voyage, had directed the course of our ships with a view to find them, both on account of these Caribbee islands being nearest to Spain and also in the direct track to the island of Hispaniola, where he had left some of his men when he returned to Spain. Thither, by the goodness of God and the wise management of the admiral, we came in as straight a channel as if we had sailed by a well known and much-frequented route.[1]

"This island of Guadeloupe is very large, and on the side where we arrived it seemed to us to be about twenty-five leagues in length. We sailed more than two leagues along the coast in search of a harbor. On the part towards which we moved it appeared all made up of very high mountains, and on the part we left there were extensive plains;[2] on the shore were a few small villages whose inhabitants fled as soon as they saw the sails of our ships. At last, after having gone about two leagues' distance, we found a port late in the evening.[3]

"That night the admiral resolved that some of the men should

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[1] In order to do that, Columbus started from the Canary Islands on a much more southerly course than on his previous voyage, and thus avoided sailing over the Sargasso Sea, that large area of floating sea-weed in the Atlantic Ocean, formed by the *Sargasso baccifera* and allied species. Columbus was the first person who gave a description of it.

[2] Guadeloupe really consists of two islands, Grande Terre and Basse Terre, separated by a narrow channel called Rivière Salée or "Salt River." Grande Terre is generally flat, composed of coral, limestone, and oceanic detritus, with the highest elevation less than 500 feet; while Basse Terre is of volcanic formation, and traversed from north to south by a ridge of mountains with prominent peaks. One of these culminating points is the semi-active volcano La Souffrière, about 4,500 feet high. This island was discovered on November 4, 1493, and named by Columbus, Nuestra Señora de la Guadalupe, in remembrance of the famous sanctuary of Our Lady of Guadeloupe, in the province of Extremadura, Spain, to the ecclesiastics of which monastery he had promised to give that name to some island found in the New World. The combined area of the two islands constituting Guadeloupe is 616 square miles.

[3] This port is now known as the Bay of Point-à-Pitre, one of the best in the Antilles, and is located at the south entrance of the Rivière Salée or channel between Grande Terre and Basse Terre.

land at the break of day in order to talk with the natives, and to learn, if possible, what sort of people they were, although we had already great suspicion, judging by the appearance of those who fled at our approach, that they were naked people like those whom the admiral had seen in his former voyage. In the morning several detachments under their respective captains started in different directions. One of the parties returned at the dinner hour with a boy about fourteen years of age, who said that he was one of the prisoners taken by these people. Another detachment brought in a little boy whom a man was leading by the hand, but he left him and fled. This boy was sent on board immediately with some of our men. Other detachments remained away longer, and brought along with them several women, natives of this island, together with other women from among the captive ones, who came willingly and of their own accord. The captain of another detachment of six men,[1] not knowing that we already had information about the inhabitants of this island, advanced farther away into the interior and all were lost. They could not find their way back to the coast until after four days. We thought they had been killed and eaten up by the people called Caribbees, for we could not account for their long absence in any other way, since there were among them pilots who, by their knowledge of the stars, could navigate either to or from Spain, so that we imagined they could not lose themselves in so small a place.[2] When they at last came back, they reported they had found many aromatic plants, delicious fruits, several kinds of unknown birds, and some considerable rivers,[3] but all in a woodland so thick with luxuriant vegetation and high trees that they could not see the sky even by climbing the trees, and only with great difficulty walk. Finally they came out upon the seashore, and following the line of coast returned to the fleet. They brought with them some women and boys, ten in number.

"These stragglers came back from the interior of the island in such an emaciated condition, that it was distressing to see them. The admiral had sent searching parties into the woods to find them; they hallooed, and sounded their trumpets, and fired their arquebuses, but to no avail.

[1] Some other authorities have said eight instead of six men.

[2] The captain of this detachment was Diego Marquez, the overseer of the fleet and master of one of the caravels, who had landed early in the morning with several men belonging to his vessel, and went, without permission of Columbus, on an exploring expedition into the interior of the island.

[3] The principal rivers of the island of Guadeloupe are now called the Goyaves, the Lamentin, and the Lazarde.

"On the first day of our landing several men and women came on the beach, down to the water's edge, and gazed at the ships in astonishment at so novel a sight, but when a boat with some of our men was sent ashore, in order to speak with them, they cried aloud 'taíno,' 'taíno,' which is as much as to say 'friends,' 'friends,' and waited for the landing of the sailors, standing, however, by the boat in such manner that they might escape from our men when they wanted to do so. The result was that none of those men could be persuaded to join us, and only two of them were taken by force and led away. More than twenty of the female captives were taken with their own consent, and a few of the native women, by surprise, and forcibly carried off. Several of the boys, who were captives, came to us, fleeing from the natives of the island who had taken them prisoners in their own country.

"We remained eight days at that port[1] in consequence of the temporary loss of the before-mentioned captain and six men composing one of the detachments, and in that time we went on several occasions on shore, passing amongst the dwellings and through the villages located near the coast. We found there a vast number of human bones and skulls hung up about the houses, like vessels intended for holding various things. Very few men were there to be seen around, and the women that we had captured informed us that this was on account of the departure of ten canoes full of men having gone out to make war upon the inhabitants of other neighboring islands.[3]

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[1] The port referred to here is the handsome bay of Point-à-Pitre.

[2] These villages were composed of twenty or thirty houses, square in shape for the common people and circular for their chiefs, all surrounding an open place or plaza called batéy, among the Lucayans, a name now-a-days applied to the open space occupied by the different buildings of a sugar plantation. The houses had the name bohíos, and were made of trunks of trees, generally the royal-palm, and covered around with yagüas, that is, the large broad leaves covering the fruit of the royal-palm, which resemble thin, very pliable boards, from one to four feet wide and four to eight feet long, intertwined with reeds called bejucos, and still so named, and continued to the present day to be employed in the backwoods of Cuba, Puerto Rico, Santo Domingo, etc., as the abode of the farmers. The roofs of these huts are covered with the common, long, and flaked leaves of the same royal-palm, and have in front a sort of portico or extension of the roof that serves as shelter from the hot sun and from the rain.

At the entrance of one of these houses in the island of Turuqueira the explorers found some images of serpents, tolerably well carved in wood. Perhaps this house was the church or place of worship of the idolatrous aborigines of America.

[3] When the Caribbee men went forth on their predatory expeditions, always

"These islanders appear to us to be more civilized than those who had hitherto been seen, for although all Indians have houses made of straw,[1] yet the dwellings of these people are constructed in a much superior fashion, better stocked with provisions, and exhibit more evidences of industry both on the part of the men and of the women. They had a considerable quantity of cotton, already spun and also prepared for spinning, and many cotton blankets so well woven as to be in no way inferior to similar ones made in our country.[2]

"We inquired of the women who were prisoners of the inhabitants of this island, what sort of people these islanders were, and they replied, Caribbees. As soon as these women learned that we abhor such kind of people because of their evil practice of eating human flesh, they felt delighted. And after that, if any man or woman belonging to the Caribbees was forcibly brought forward by our men, they informed us (but in a secret way) whether he or she belonged to that kind of people, evincing at the same time by their dread of their conquerors that those poor women pertained to a vanquished nation, though they well knew that they were then safe in our company.[3]

accompanied by their caciques, or kings, the women remained at home to defend their shores from invasion, and they were as good archers as the men, partaking of the same warrior spirit as their husbands and male relatives.

[1] Dr. Chanca here makes a mistake, for, though the houses of the native Indians of the Antilles may have had the appearance of being built of straw, they were almost exclusively made of the component parts of the royal-palm (*Roystonca regia*), as stated in the above explanatory note. He probably considered those houses made of straw because they certainly had that appearance, and in the short space of time which he had had to observe them he did not get the opportunity of seeing one of those huts in process of construction.

[2] They possessed also the art of making household utensils of clay, which they baked in kilns like the potters of Europe.

[3] Prof. Justin Winsor, the accomplished librarian of Harvard College, in his "Christopher Columbus," referring to the Caribbee Indians, makes the following interesting statements: "The contiguity of these two races, the fierce Carib and the timid tribes of the more northern islands (the Lucayans) has long puzzled the ethnologist. Irving indulged in some rambling notions of the origin of the Carib, derived from observations of the early students of the obscure relations of the American peoples. Larger inquiries and more scientific observations has, since Irving's time, been given to the subject, still without bringing the question to recognizable bearings. The craniology of the Carib is scantily known, and there is much yet to be divulged. The race in its purity has long been extinct. Lucien de Rosny, in an anthropological study of the Antilles published by the French Society of Ethnology in 1886, has amassed considerable data for future deductions."

"We were able to distinguish which of the women were natives of this island and which captives, by the distinction that a Caribbee woman wore on each leg two bands or rings of woven cotton, one fastened around the knee and the other around the ankle, by this means making the calves of their legs look big and the above-mentioned parts small, which I imagine they do because they believe this sort of adornment makes them pretty and graceful: by that peculiarity we distinguish them.[1]

"These captive women told us that the Carribbee men use them with such cruelty as would scarcely be believed; and that they eat the children which they bear to them, only bringing up those which they have by their native wives. Such of their male enemies as they can take away alive, they bring here to their homes to make a feast of them, and those who are killed in battle they eat up after the fighting is over. They claim that the flesh of man is so good to eat that nothing like it can be compared to it in the world; and this is pretty evident, for of the human bones we found in their houses every thing that could be gnawed had already been gnawed, so that nothing else remained of them but what was too hard to be eaten. In one of the houses we found the neck of a man undergoing the process of cooking in a pot, preparatory for eating it.[2]

"The habits of these Caribbees are beastly.

[1] These bands or rings of woven cotton worn by the Caribbee women were about two inches wide and sometimes embellished with pieces of gold, pearls, and valuable stones; a sort of double garter known by them as llauto.

[2] Alexander von Humboldt, in his "Personal Narrative of Travels to the Equinoctial Regions of America," speaking about the Caribbees, makes the following instructive observations, worthy of serious reflection, upon the baneful influence of fads and fancies: "Reproaches addressed to the natives on the abominable practice which we here discuss, produce no effect; it is as if a Brahmin, travelling in Europe, were to reproach us with the habit of feeding on the flesh of animals. In the eyes of the Indian of the Guaisia, the Chernvichaena was a being entirely different from himself, and one whom he thought it was no more unjust to kill, than the jaguars of the forest. It was merely from a sense of propriety that, whilst he remained in the mission, he would only eat the same food as the Fathers. The natives, if they return to their tribe (irse al monte), or find themselves pressed by hunger, soon resume their old habits of anthropophagy. And why should we be so much astonished at this inconstancy in the tribes of the Orinoco, when we are reminded, by terrible and well-ascertained examples, of what has passed among civilized nations in times of great scarcity? In Egypt, in the thirteenth century, the habit of eating human flesh pervaded all classes of society; extraordinary snares were spread for physicians in particular. They were called to attend persons who pretended to be sick, but were only hungry; and it was not in order to be consulted, but devoured. An historian of great veracity, Abd-allatif, has related how a practice, which at first inspired dread and horror, soon occasioned not the slightest surprise."

"There are three islands: this one on which we are is called by the natives *Turuqueira;*[1] the other, which was the first we saw, is named *Cayre,*[2] and the third *Ayay.*[3] There is a general resemblance among the natives of these three islands, as if they were of the same lineage. They do no harm to one another, but each and all of them wage war against the inhabitants of the other neighboring islands, and for this purpose sometimes they go as far as a hundred and fifty leagues in their canoes,[4] which are a narrow kind of boat, each made out of a single trunk of a tree.[5] Their arms are arrows, in place of iron weapons, and as they have no iron, some of them point their arrows with a sharpened piece of tortoise-shell, and others make their arrow heads of fish spines, which are naturally barbed like coarse saws. These arms are dangerous weapons only to naked people like the Indians, causing death or severe injury, but to men of our nation they are not much to be feared.[6]

[1] The island of Guadeloupe, named by Columbus Nuestra Señora de la Guadalupe, as already explained.

[2] The island of Dominica.

[3] This must have been the island now known as Martinique, though Dr. Chanca fails to mention having been there. It is situated 30 miles south by west from Dominica and 20 miles north of St. Lucia. It is almost entirely of volcanic formation, with several well marked volcanic mountains, among which the loftiest peak is that of Mount Pelée in the northwestern part of the island. Before the terrific and appalling eruption of May 8 and August 30, 1902, which destroyed the city of Saint-Pièrre and killed over 30,000 inhabitants, it had an altitude of about 4,500 feet. This volcano had been previously twice in eruption, in 1762 and in 1851.

At the time of the discovery no one speaks of having seen a volcano there; and it is my humble opinion that, like the volcano La Souffrière, on Guadeloupe, it is of subsequent origin. On Martinique there are to-day, as on Guadeloupe, several extinct volcanoes which in ages gone by were probably as active as Mount Pelée and La Souffrière some years ago. Mount Pelée remains at present entirely inactive in spite of the great number of slight earthquakes in all the neighborhood, and the tremendous upheavals in South America, California and Jamaica. Perhaps these subterranean convulsions are the very cause of the stoppage of its discharging activity.

[4] That is to say, 450 Spanish miles or about 376 English miles, which means as far as Puerto Rico, Santo Domingo, and Cuba to the nortth, and Trinidad, Curaçoa, and the north coast of South America to the south.

[5] In the language of the Caribbees these boats were called canaóas, and among the Lucayans acalli, the largest ones, holding forty or fifty persons, being known as piraguas, which is still the Spanish name for that kind of Indian boat, called in English pirogue.

The trunk of the tree of which these water crafts were made was excavated by burning into a suitable shape. They had no sails and were impelled by a long paddle of light timber, broad and flat at each end, and held at its center by both hands.

[6] Dr. Chanca did not then know that these Caribbee arrow points were poisoned, probably with the juice of a plant as the manchineel-tree. The

"In their wars upon the inhabitants of the neighboring islands, these people capture as many of the women as they can, especially those who are young and handsome, and keep them as body servants and concubines; and so great a number do they carry off, that in fifty houses we entered no man was found, but all were women. Of that large number of captive females more than twenty handsome women came away voluntarily with us.[1]

"When the Caribbees take any boys as prisoners of war, they remove their organs, fatten the boys until they grow to manhood and then, when they wish to make a great feast, they kill and eat them, for they say the flesh of boys and women is not good to eat. Three boys thus mutilated came fleeing to us when we visited the houses.

"We left that island eight days after our arrival.[2] The next day at noon we saw another island, not very large, at about twelve leagues' distance from the one we were leaving.[3] On that evening we saw another island, but finding there were many sandbanks near it we dropped anchor, not venturing to proceed until the morning.[4] On the morrow another appeared, of considerable size,[5] but

death of a Spanish sailor wounded with one of these arrows, which penetrated his buckler and pierced his side during a fight with a party of these Indians, clearly demonstrated that that native weapon was not so harmless as it appeared to be.

[1] These captive women were natives of the island of Borinquen, Puerto Rico of to-day, who seemed to be handsomer and more attractive than the Caribbee women.

[2] Tuesday, November 12, 1493. The island here referred to is Guadeloupe.

[3] This was Montserrat, so named by Columbus because its general appearance reminded Fray Bernal Boil (a high ecclesiastic born in the province of Tarragona, Spain, who had been especially selected by King Ferdinand to accompany this expedition) of the celebrated mountain of Montserrat, in his native province, where the Benedictine monastery of which he was one of the Fathers is located. I have myself visited Montserrat, 30 miles north-west from Barcelona, and 24 miles in circumference, which is, in my opinion, one of the most beautiful mountains in the world. It is the Mons Serratus of the ancient Romans, with its loftiest point, where the monastery is located, a little over 4,000 feet in height. At present there is here, as in some of the mountains of Switzerland, a railroad that makes the ascent and descent by going around this remarkable promontory over jagged pinnacles and steep precipices. The monastery is visited annually by about 80,000 pilgrims and tourists. This mountain is also a popular place for the people of Barcelona to spend two or three days on picnics and excursions, and for newly-married couples of the middle class to enjoy their honeymoon.

[4] Columbus called it "Santa Maria la Redonda" on account of its semicircular shape. It is a rocky, barren islet, between the islands of Nevis (called Nieves in Spanish) and Montserrat, so steep on all sides that it seems inaccessible without ladders or ropes thrown from the top, and is inhabited only by workers in the phosphate mines.

[5] This was Santa Maria la Antigua. It is 28 miles long and 20 broad,

we touched at none of these because we were anxious to convey comfort and consolation to our people, who had been left on the first voyage in the island of Hispaniola. It did not please God, however, to grant us our desire, as will hereafter appear in this narrative.

"The next day at the dinner hour we arrived at an island which seemed to be worth finding, for judging by the extent of cultivation in it, it appeared very populous.[1] We went thither and put into harbor.[2]

"The difference between these Caribbees and the other Indians, with respect to dress, consists in wearing their hair very long, while the others have it clipt irregularly; also because they engrave on their heads innumerable cross-like marks and different devices, each according to his fancy; and they make these lasting marks with sharpened bamboo sticks. All of them, both the Caribbee and the other Indians, are beardless, so that it is an unusual thing to find one of these men with a beard. The Caribbees whom we have taken prisoners have their eyes and eyebrows stained circularly around, which I think they do for ostentation and also because it gives them a ferocious appearance.[3]

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having a broken and elevated surface, and its soil is fertile. Now it is called only Antigua, and is the most important of the Leeward group of the British West Indies; its population, including that of the island of Barbuda, is at present 36,819 inhabitants.

[1] Called by Columbus, St. Martin. It is of triangular shape, each side being from 9 to 11 miles long. The climate is healthy, but there is little natural water to drink, the inhabitants depending almost entirely on rain water. Since 1648 it has been divided between France and Holland. The French portion, a dependency of Guadeloupe, has an area of 20 square miles and a population of 3,500. The Dutch portion is a dependency of Curaçao, has an area of 18 square miles, and a populataion of 3,984 inhabitants.

[2] Grand Bay must have been this harbor.

[3] The dyeing material they used for that purpose was obtained from the red or yellowish-red seeds of a small tree, called by the Indians catabi, now known in the French West India Islands by the name of roucouyer, in Spanish bija (*Bixa orellana*), and in English arnotta and annotte, whose leaves are heart-shaped. It is now employed for coloring cheese and butter, and, in Germany, for coloring white wines. In Jamaica it is used as medicine, in the treatment of dysentery, and is considered to possess astringent and stomachic qualities.

Those marks and stains about the face and head of the Caribbees remind me of the similar custom of the ancient Romans, who after their victorious return entered Rome riding in their chariots with the face and neck painted red, in imitation of fire, as stated by Christopher Landino in his commentaries to Dante's "Divine Comedy"; and as was also done by the ancient Britons, as recorded by Julius Caesar in his famous Commentaries.

"One of the Caribbees we held as captives told us that in one of the islands belonging to them, and called Cayre[1] (which was the first we saw, though we did not land on it), there is a great quantity of gold, and that if we were to give its inhabitants nails and tools with which to make their canoes, we might bring away as much gold as we like.

"On the same day we arrived we left that island,[2] having being there no more than six or seven hours, and steering for a point of land that appeared to lie in our intended course of travel, we reached it by night. On the morning of the following day we coasted along, but found that although it was very large in extent it was not a continuous territory, for it was divided up into more than forty islets.[3] The land was very high and most of it barren, an appearance which we had never observed in any of the islands visited by us before or since: the ground seemed to me to suggest the probability of its containing minerals.

"We proceeded along the coast the greater part of that day, and on the evening of the next we discovered another island called by the Indians Borinquen,[4] which we judged to be on that side about thirty leagues in length, for we were coasting along it the whole of

[1] As already stated, this was the island of Dominica.

[2] The island to which Columbus gave the name of Santa Cruz, and now known as Saint Croix, where the explorers anchored on Thursday, November 14, 1493. It lies 65 miles east southeast of Puerto Rico, and is 83 square miles in extent. Together with the islands of St. Thomas and St. John, it forms to-day a Danish colony.

Here in this island, the most northerly one inhabited by the fierce Caribbees, the Spaniards had their first fight with the Indians in trying to capture a canoe with two women, one man and a boy. Two of the Spaniards were wounded with arrows, and one of them, a Biscayan sailor, died later. The women fought as bravely as the men, and one of them wounded the sailor. He was duly buried on the shore of the island of Haiti, as the Lucayans called Hispaniola or Santo Domingo.

[3] Columbus named the largest of all these islets Santa Ursula, and the others "The Eleven Thousand Virgins" (Las once mil vírgenes), which are now called the Virgin Islands. Santa Ursula is known to-day as *Tórtola,* which means turtle-dove. It is 11 miles long and 4 miles in its greatest breadth. The principal bay is on the southeast, and on that side there is a double curve of islets and reefs enclosing a vast roadstead with calm water, called Virgin's Causeway. The group of islets has an area of 58 square miles, and a population of 4,639 inhabitants. Cotton and sugar are cultivated for exportation. The chief town is called Roadtown.

[4] This was the island of Puerto Rico, which Columbus named "San Juan Bautista" (St. John the Baptist). The date of its discovery was Saturday, November 16, 1493.

one day.[1] This island is very beautiful, and, apparently, very fertile. Here the Caribbees come to make war upon its inhabitants, and often carry away many prisoners.

"These islanders have no large canoes, nor any knowledge of navigation, as our prisoners inform us, but they use bows like those of the Caribbees; and if by chance, when they are attacked, they succeed in taking prisoners some of the invaders, they eat them up in like manner as the Caribbees themselves do.

"We remained two days in a port of that island,[2] where a great number of our men went on shore, but we were not able to talk with the natives because at our approach they all fled, from fear, I suppose, that we were the Caribbees.

"All the above-mentioned islands were discovered on this voyage, the admiral not having seen any of them on his former trip. They are all very beautiful and possess a most luxuriant soil, but this island of Borinquen appears to exceed the others in beauty.[3]

"Here almost terminates the group of islands which on the side toward Spain had not been seen before by the admiral,[4] although we regard as a matter of certainty that there is land more than forty leagues beyond the southernmost of these newly discovered islands. We believe this to be the case because two days before we saw the first island,[6] we had observed some birds called 'rabihorcados,' which are marine birds of prey that do not sit nor sleep upon the water, making circumvolutions high in the air at the close of the evening,

[1] An astonishingly-exact calculation of Dr. Chanca, for Puerto Rico is 90 miles long from east to west (very nearly the equivalent of 30 Spanish leagues), and 36 miles broad, with an area of 3,600 square miles and a population of 953,243 inhabitants. The capital is San Juan, but the city of Ponce is the acknowledged metropolis, the first with a population of 32,048 inhabitants, and the second numbering 27,952 souls.

[2] The port here referred to is now known as the bay of Mayagüez.

[3] The islands of St. Kitts and Nevis are not mentioned by Dr. Chanca in this account of the voyage, but they must have been seen by the explorers, for another writer of those times speaks of them as "San Cristobal" and "Nuestra Señora de las Nieves," respectively.

[4] Here ended the Caribbee Islands, the account of whose fierce and savage inhabitants was received with eager curiosity by the learned of Europe. Traces of that same race of cannibals have more recently been discovered—and in a masterful and philosophical way described by Alexander von Humboldt—far in the interior of the country through which flows the great Orinoco river of Venezuela.

[5] It is truly admirable how nearly exact was this calculation of Dr. Chanca, for the comparatively large islands of Curaçoa and Trinidad, and the North coast of Venezuela, are about that distance from Martinique.

[6] The island of Dominica.

with the object of taking their reckoning of where they are and flying after that in a straight line towards land to sleep. These birds could not have been going to spend the night at more than twelve or fifteen leagues' distance from where they were, because it was already late in the evening, and the direction they took in their flight was toward the South.[1] From all this we concluded that there was land in that direction still undiscovered; but we did not go in search of it because it would have taken us out of our intended route. I hope that in a few more voyages it will be discovered.[2]

"It was at dawn when we left the above-mentioned island of Borinquen,[3] and on that day prior to nightfall we caught sight of land, which although not recognized by any of those who had come hither in the former voyage, we believed to be Hispaniola from the information given us by the Indian women we had with us; and in said island we remain at present.[4]

"Between it and Borinquen another island appeared at a distance, but it was not of great size.[5]

"When we reached Hispaniola, the land at the place where we approached it was low and very flat,[6] on seeing which a general

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[1] Probably these sea-birds were going to spend the night on the island of Martinique, 30 miles southwest of Dominica and 20 miles north of St. Lucia.

[2] And that land was in fact discovered, as predicted by the learned author of this overlooked important historical document, in the very next, or third voyage of Columbus. On July 31, 1498, he discovered the island of Trinidad, and caught a glimpse of terra firma at the delta of the Orinoco river. Afterwards he discovered the islands of Margarita, Tobago, Buen Aire, and Curaçoa, although he did not land at any of them. In his passage from the Gulf of Paria to the island of Hispaniola, Columbus also discovered on his third voyage, sailing along without touching at them, the little islands to which he gave the names of Asunción, Concepción, Sola, de los Testigos, de la Guarda, and de los Frailes, all belonging to the group known as the Windward Islands.

[3] That was the dawn of November 18, 1493. The explorers sailed from the bay known to-day as Mayagüez, where they had landed and visited a village located on the shore and construeted, as usual among these Indians, around a common square, like a market-place, from which a spacious road led to the sea-shore, having fences on each side of the way made of interwoven reeds and enclosing fruitful gardens. At the end of this road was a kind of terrace, or lookout, overhanging the waters of the bay.

[4] It was in fact the island of Hispaniola.

[5] This was the small island to which Columbus gave the name Mona, situated in the channel between Puerto Rico and Santo Domingo, now known as Mona Passage.

[6] That locality must have been between Point Macao and Point Engaño, which is flat. The higher land of the north coast begins at Point Macao.

doubt arose as to its identity, because neither the admiral nor his companions on the first voyage had seen it.

"This island of Hispaniola, being a large one, is divided up into provinces: that part which we first touched at, is called by the natives *Haití;* another province adjoining it, they name *Samaná,* and the next province is known by them as *Bohío,* which is the place where we now are. These three provinces are subdivided into smaller portions.

"Those who have seen the length of its coast state that this is an island two hundred leagues long, and I, myself, should judge it not to be less than a hundred and fifty leagues. As to its breadth, nothing is hitherto known. At the date of writing this letter, it is already forty days since a caravel left here with the object of circumnavigating it, and it has not yet returned.[1]

"The country is very remarkable, and contains a vast number of large rivers and extensive chains of mountains, with broad, open valleys, and the mountains are very high. It looks here as if the grass is never cut throughout the whole year. I do not think that they have any winter here, for at Christmas we found many bird-nests, some containing the young birds and others the eggs. No four-footed animal has ever been seen in this, nor in any of the other islands, except some dogs of various colors, as in our own country, but in shape and size like lap-dogs. Of wild, ferocious beasts, there are none.

"I came near forgetting to mention another four-footed little animal, in the color of its hair, size, and fur, like a rabbit, but with long tail and feet similar to those of a rat. These animals climb up the trees, and many of our men who have eaten them say their taste is very good.

"There are many snakes, small in size, also lizards, but not so many, for the Indians consider them as great a luxury as we do pheasants. These lizards are of the same size as ours, but different in shape.

"In a small adjacent island, close by a harbor which we named 'Monte Cristo,' where we stayed several days, our men saw an enormous kind of lizard which they said was as large around the body as a calf, and the tail shaped like a lance. They often went out to kill it, but bulky as it was it disappeared in the thicket and got into the sea, so that they could not catch it.

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[1] On the parallel of 18°25′ N. latitude the island of Santo Domingo has an extreme length of 400 miles, and its extreme breadth may be taken to be as of 150 miles on the meridian 71°20′ West from Greenwich Observatory.

"There are, both in this and in the other islands, an infinite number of birds like those we have in our country, and many others such as we had never seen. No kind of domestic fowl has been found here, with the exception of some ducks in the houses of the island of Turuqueira.[1] Those ducks were in size larger than the ones we have in Spain, though smaller than geese, very pretty, with flat crest, and most of them as white as snow, but some also black.

"We ran along the coast of this island nearly a hundred leagues. We continued our course till we came to a harbor, which we named Monte Cristo, where we remained two days in order to observe the position and formation of the land in its neighborhood. There was a large river of excellent water close by,[2] but the surrounding ground was inundated, and consequently ill-calculated for a place of habitation.[3]

"As we went on making observations of this river and the neighboring land, some of our people discovered the bodies of two dead men in the grass by the river bank, one with a rope around his neck and the other with another rope round his feet: this was on the first day of our landing there.[4] On the following day they found two other corpses farther on along the river, and it was noticed that one of them had a great quantity of beard. This was regarded as a very suspicious circumstance by many of us, because, as I have already said, all these Indians are beardless.

"This harbor is twelve leagues from the place where the Christians had been left by the admiral on his return to Spain from the first voyage,[5] and under the protection of Guacamarí, a king of these Indians who I suppose is one of the principal sovereigns of this island. After we anchored at said spot,[6] the admiral ordered two lombards to be fired in order to see if there was any response from the Christians, who would fire in return, as a salute, for they also had lombards with them; but we received no reply, nor did we see on the sea-shore any body, or any sign of houses whatever.

[1] As already explained, the old island of Turuqueira is Guadeloupe.

[2] This river was called by the natives Yaquí, and has now the name Río de Oro.

[3] This plain remark shows how well fitted was Dr. Chanca, as a medical man and a sanitarian, to accompany that large number of explorers and colonizers, which included many distinguished men.

[4] That day was November 28, 1493.

[5] A distance of 36 Spanish miles, equivalent to about 31 English miles.

[6] The spot here referred to is the harbor named by Columbus, on his first voyage, La Navidad (the Nativity), reached by this large fleet of the second voyage on the night-fall of November 27, 1493.

Our people then became very much chagrined, and began to realize what the circumstances naturally suggested.

"While all of us were in this depressed state of mind, the same canoe with several Indians on board which we had seen that afternoon, came up to where we were anchored, and the Indians with a loud voice inquired for the admiral. They were conducted to the admiral's vessel, and remained there on board for three hours talking with the admiral in the presence of us all. They said that some of the Christians left on the island had died of disease, others had been killed in quarrels amongst themselves, and that those who remained were all well. They also said that that province had been invaded by two kings named Caonabó and Mayrení, who burned all the houses, and that king Guacamarí was at another place, some distance away, lying ill of a wound in his leg, which was the reason why he had not come himself in person.

"Next morning some of our men landed by order of the admiral, and went to the spot where the Christians had been housed. They found the building, which had been fortified to a certain degree by a palisade surrounding it, all burned up and levelled with the ground.[1]

"They found also some rags and stuffs which the Indians had brought to set the fort and the houses in the environs on fire. They observed, too, that the few Indians seen going about in that neighborhood were shy, and dared not approach, but, on the contrary, when called, fled.

[1] The little wooden fortress in which Columbus had left 38 men the year before was built with the remains of the caravel *Santa María,* the largest of the three small vessels that discovered the Western Hemisphere of our planet, which had been wrecked on the reefs of that harbor. That small band of fool-hardy Spanish people was left well provided with arms and ammunition, medical and surgical supplies; but they all perished for lack of discipline and disregard of the orders and admonitions of Columbus before he returned to Spain.

Their commander was the hidalgo Diego de Arana Enriquez, who was a brother of Donna Beatríz, the second wife of Columbus (by whom he had his second son, Don Fernando, born at the city of Cordova on August 15, 1488), and he had as his lieutenants Pedro Gutierrez and Rodrigo de Escovedo.

Among those 38 men killed by the Indians was one of the two physicians or físicos (as they were then called) who had accompanied Columbus on his first voyage, and was left to care for the health of those boldly-venturous Spaniards. His name was Maese Juan. The name of the other ship surgeon, who returned with Columbus to Spain, was Maese Alonso. In my monograph on "The Medical History of Christopher Columbus, and the Part Taken by the Medical Profession in the Discovery of America," I mention these two worthy members of the medical profession, who were the first physicians to tread American soil.

"We had already been told by one of the Indians who, as interpreters, were carried to Spain and brought back with us, and who had conversed on board with the natives that came in their canoe to talk to the admiral, that all the Christians left on that island had been killed, but we did not believe it. Caonabó and Mayrení with their warriors had made an attack upon them, and burnt down the buildings.

"We went to the place where Guacamarí was. When we arrived there, we found him stretched upon his bed, which was made of cotton net-work, and according to their custom, suspended.[1] He did not arise, but from his bed made the best gesture of courtesy of which he was capable. He showed much feeling, and began by explaining to the best of his persuasive power how the Christians had died of disease, others had gone to the province where Caonabó was king, in search of gold mines, and had been killed there, and the rest had been attacked and slain in their own houses. Judging by the condition in which the dead bodies were found, I think it was not yet two months since this calamity had occurred.

"Guacamarí then made a present of eight marks and a half of gold to the admiral,[2] five or six hundred pieces of precious stones of different colors,[3] and a cap ornamented with similar stones, which I think the Indians must value very highly because that cap was delivered with a great deal of reverence.[4]

"It appears to me that these people put more value upon copper than gold. They beat the gold they find into very thin plates, in order to make masks of it, and then set it in a cement which they prepare for that purpose. Other ornaments they also make of the gold, which they wear on the head and hanging from their ears and nostrils,[5] and for this object it is equally required that the gold should be in the shape of a thin plate. But it is not the costliness

[1] This is the first mention in history of a hammock, called hamaca by those Indians, and still so named in Spanish.

[2] The Spanish mark, as a measure for gold and silver money, weighed eight Spanish ounces, equivalent to two-thirds of a Troy pound, and in money value was equal to 50 castellanos, or pesos as this standard Spanish coin is now called. The 50 castellanos in bullion value to-day would be worth about $150 in U. S. currency.

[3] The diamond was not included in these precious stones, for it has never been found in the Antilles, nor the emerald, ruby, or sapphire.

[4] These Indians called this covering for the head, chuco, and it was worn in battle by the caciques like a helmet.

[5] These gold ornaments hanging from the ears or nostrils were called by the Lucayans, chaquina, and when used around the neck or the wrist like a necklace or bracelet, chaquira.

of the gold that they value in their ornaments; it is its showy appearance.

"The surgeon of the fleet[1] and myself being present, the admiral told Guacamarí that we were skilled in the treatment of all human ills, and wished that he would show us his wound. Guacamarí replied that he was willing, and then I said it would be better, if possible, to examine the wound outside the house,[2] because there were so many people inside of it, that made the place somewhat dark, and we needed better light. To this he consented, but in my opinion more from fear of the truth being found out than from any inclination on his part to do so, and went out of the house leaning on the arm of the admiral. After he was seated, the surgeon approached him and began to untie the bandage that covered the wound. Guacamarí then told the admiral that his injury had been inflicted with a *ciba,* by which he meant with a stone. When the wound was uncovered, we examined it carefully; and it is a fact that there was no more wound on that leg than on the other, although he cunningly pretended, when we touched it, that it pained him very much.[3]

"There were certainly many proofs of an invasion by a hostile people, so that the admiral was at a loss what to do. He with many others of us thought, however, that for the present at least, and until we could ascertain the truth of what had happened, it was better to conceal our distrust.

"Fish is abundant here, an article of food that we greatly needed, for our provision of meat was running short, and it is a singular kind of fish, more wholesome than those we have in Spain. The climate does not allow the fish to be kept from one day to another, for all animal food speedily become unwholesome on account of the great heat and dampness.

"Large quantities of vegetables have been planted, and they cer-

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[1] On that expedition of the Spaniards there were, besides Dr. Chanca, in charge of the general health of the explorers (many of them distinguished persons belonging to the Court of Ferdinand and Isabella, as already explained), a ship surgeon, called in Spain in those times, físico or physicist, and also a pharmacist.

[2] Dr. Chanca unquestionably had a suspicion that Guacamarí was feigning, and wanted to be sure. As it afterward turned out, he was right in his incredulity.

[3] This remakable example of refined hypocrisy and deceit in an uncivilized American Indian does not contribute to the idea of straightforward, impulsive sincerity and honesty of the human race in its unsophisticated state. The perfidy of Guacamarí brings to my memory the origin of the well-known proverbial American expression, "Honest Indian."

tainly attain a more luxuriant growth here in eight days than they would in Spain in twenty.

"We are frequently visited here by a large number of Indians, accompanied by their caciques, who are their captains or chiefs, and many women. They all come loaded with 'ages,' a sort of turnip, very excellent food, which they cook and prepare in various ways. This food is very nutritious, and has proved of the greatest benefit to us all after the privations we endured when at sea, which in truth were more severe than man ever suffered. This age the Caribbee Indians call nabi.

"These Indians barter their gold,[1] provisions, and every thing they bring with them, for tags, nails, broken pieces of darning-needles, beads, pins, laces, and broken saucers and dishes. They all, as I have said, go naked as they were born, except the women of this island,[2] who, some of them, wear a covering of cotton, which they bind around their hips, while others use grass and leaves of trees.[3]

"When these Indians wish to appear full-dressed, both men and women paint themselves, some black, others white and red, and different combinations of colors, in so many devices that the effect produced is very laughable; they also shave some parts of their heads, and in other parts of it wear long tufts of matted hair, which give them an indescribably ridiculous appearance. In short. whatever would be looked upon in our country as characteristic of a madman, is here regarded by the most prominent Indians as a mark of distinction.

"In our present position, we are in the neighborhood of many mines of gold, not any one of which, we are told, is more than twenty or twenty-five leagues off. The Indians say that some of them are in Niti, a place in the possession of Caonabó,[4] that Indian king who killed the Christians; other mines are located in another place called Cibao,[5] which, if it please God, we shall see with our

[1] The Lucayans called gold, nucáy.

[2] The island of Santo Domingo, and also the native women of Cuba.

[3] That covering of cotton was called nagua, by these Indians, from which the Spanish word enagua, meaning the inner white skirt of a woman's dress, is derived.

[4] He was a Caribbee by birth and ruled over the province of Hispaniola, called by the aborigines Mangana, in which were the mountains named Cibao. The appellation Caonabó, like all names of persons and of places in almost every Indian language, had a meaning, equivalent to Lord of the Golden House, and seeming to indicate the great wealth of his dominions.

[5] This was the name given to a chain of mountains which traverses the center of the Island of Santo Domingo.

own eyes before many days have passed; indeed, we should go there at once were it not because we have so many things to attend to that there are not enough men among us to do it at present. And this is in consequence of one-third of our people having fallen sick within four or five days after we landed here, which misfortune I think has happened principally on account of the toil and privations of the journey, to which must be added the variableness of the climate;[1] but I trust in our Lord to be able to restore all the sick to health.[2]

"My idea of these Indians is that if we could talk their language, they would all become converted to our religion,[3] for they do before the altars exactly the same things they see us doing, as, for instance: kneeling and bowing, singing the Ave María, or doing any other devotional exercises, and making the sign of the cross over one's self. They all say that they wish to become Christians, for, in reality, they are idolaters, having in their houses many kinds of strange figures.[4] I asked them the meaning of those figures, and they told me 'things of Turey,' by which they meant 'of Heaven,' once I made the pretence that I was going to throw those figures into the fire, and this action of mine grieved them so much that they began to weep. They believe that every thing, no matter what, we have brought with us, comes from Heaven, and also called it *Turey*.

[1] The climate changes suddenly in these West Indian islands from very hot and dry to comparatively cool and very damp, due to heavy and long-continued rain.

[2] Columbus himself was also sick with malaria fever for several weeks, and seven months later suffered a dangerous malady, which I have ventured to diagnose as typhus, or "ship fever," in my monograph on "The Medical History of Christopher Columbus" (which is the first, and only writing in existence on that subject), published in English in "Journal of the American Medical Association" for May 5, 1894, and "The Dublin Journal of Medical Science" for August and September, 1894. I have also published it in Spanish, French, and Italian.

[3] This belief of Dr. Chanca was fully confirmed in a very short time afterward, for all those Indians soon became strong Catholics, the same as are the Indians still remaining in all the Spanish-speaking countries of America.

[4] Most of them were rough images of snakes, crocodiles and other creeping animals. Their name for the evil spirit or devil was cemí. They had also speaking gods, or oracles, and their augurs or priests were known as buhitís, who played, besides, the same parts among them as the "medicine-men" of the Indians of these northern regions of America. The religious songs of the Lucayans, which were also their war songs to celebrate their victories—but not the war-dance or ghost-dance, and songs, of the North American indigines before their battling against some foe—and their funeral chants, when burying their dead caciques and noblemen, were called areitos.

"The little time that we have spent on land has been so much occupied in seeking for a place where to establish a settlement,[1] and in providing ourselves with things we needed, that we have had little opportunity of becoming acquainted with the natural productions of the soil. In spite of this drawback, we have already seen many marvellous things. For instance: trees producing a soft silky fiber fine enough (according to the opinion of those who are acquainted with that industrial art) to be woven into good cloth. And of this kind of trees there are so many, that we might load our vessels with the fiber, though it is somewhat difficult to gather it because these trees are very thorny, but some means can easily be found to overcome that difficulty.

"There are also cotton plants as large as peach trees, which all the year round produce cotton, and in abundance.

"We found other trees which produce wax, as good both in color and smell as bees-wax, and equally useful for burning; indeed, with very little difference between the one and the other.

"There is a vast number of trees which yield surprisingly fine turpentine.

"Tar is found in abundance, of very good quality too.

"We discovered trees which, in my opinion, bear nutmegs, but at present without fruit on them, and I say so because the bark tastes and smells like nutmegs.

"I saw one root of ginger, which an Indian was carrying around his neck.

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[1] They found at last a convenient place. It was on the shore of a good bay, on the north coast and upon high ground, with two rivers of potable water near by, and the back part well closed by the thick growth of an impassible forest that protected it from being set on fire by the Indians on a night attack. The building up of the first Christian town of the New World was commenced there, in that very spot, and to it Columbus gave the very appropriate name of Isabella, his faithful defender and protectoress.

The engineers who came in that expedition at once laid out the square or plaza, and the streets; a convenient site for the church was selected, as well as another for the fortress, and a residential quarter for Columbus and the subsequent governors of the colony. These three buildings were to be made of stone, the principal houses of wood, others of intertwined reeds covered with mortar and called in Spanish, embarrado, or, in English, adobe, and the rest after the Indian fashion or bohíos.

At Isabella the first aqueduct ever built upon American soil was carried to completion, and it consisted of a trench or open ditch that conducted the water of one of the two rivers through the middle of the principal streets. This sort of irrigatory aqueduct is called in Spain, acequía, where there are several of these kind of narrow canals. The ruins of the stone buildings in a solitary waste constitute to-day the melancholy relic of that historical locality.

"There are aloes too, though not of the same kind as those we are acquainted with in Spain, but nevertheless a species of aloes that we doctors use.

"A sort of cinnamon has likewise been found, but, to speak truthfully, it is not of such a fine quality as the one we have in Spain; or perhaps this is so because it is not now the proper season to gather it, or the soil in which it was found growing in this vicinity is not well adapted.

"We have also seen here some yellow mirabolans. At this season they are lying under the trees, and as the ground is very damp they are all rotten, and have a very bitter taste, due, in my opinion, to their state of decomposition; but the flavor of those parts which in spite of that have remained sound, is the same as that of the genuine mirabolan.

"There is, besides, a very good kind of mastic.

"None of the natives of all these islands we have visited possess any iron. They have, however, many implements, also hatchets and axes, all made of stone, which are so handsome and well finished that it is a wonder how they can contrive to make them without employing iron.

"Their principal food consists of a sort of bread made of the root of a herb, half way between a tree and grass, and the *age*, which I have already described as being like the turnip, and a very good food it certainly is. They use, to season it, a vegetable called *agí*, which they also employ to give a sharp taste to the fish and such birds as they can catch, of the infinite variety there are in this island, dishes of which they prepare in different ways.

"They have, besides, a kind of grain, in appearance like hazel-nuts, very good to eat.

"They eat all the snakes, lizards, spiders, and worms that they find upon the ground, so that, according to my judgment, their beastiality is greater than that of any other beast on the face of the earth.

"The admiral had at one time determined to leave the search for the mines until he had dispatched the ships that were to return to Spain, on account of the great sickness which had prevailed among our men,[1] but afterwards he resolved to send two detachments

[1] The explorers in great number were suffering from malaria fevers, about one-third of them, as Dr. Chanca said. That disease was in those days very little known, and much less its prevention and treatment. The miraculous pulvis febrifugus orbis americani, also called by the names "The jesuits' powders" and "The countess's powders" (los polvos de la condesa, alluding thereby to the Spanish countess of Chinchon, who was the wife

under the command of two captains, one to Cibao,[1] and the other to Niti,[2] places in which, as I have already stated, Caonabó lived and ruled.[3] These two detachments in effect departed, and one of them returned on the twentieth of the month, while the other did so on the following day. The party that went to Cibao[4] saw gold in so many places that one scarcely dares state the fact, for in truth they found it in more than fifty brooks and rivers, as well as upon their banks; so that the captain said that any body who wished to seek for gold throughout that province, would find as much as he wanted.

of the Spanish vice-roy of Perú, and the first European person to be cured with that wonderful new remedy), were not yet known to Europeans. The existence, and the wonderfully curative virtue, of the mysterious "quinquina" (a corruption of the indigenous Peruvian word kina-kina, which signified the bark par excellence), that saved the lives of Charles II. of England, Louis XIV. of France, and Friedrich the Great of Germany, was at that time known only to the aborigines of the yet undiscovered kingdom of Perú. And in truth, it was not until the year 1738 that, thanks to the valuable investigations of La Condamine, the tree that produces this most precious bark was known with certainty; and he was, too, the first scientist who conceived, and carried out, the idea of transporting and transplanting that tree to other countries than the one of its natural habitat.

[1] Which word in the Lucayan language meant "stone mountain."

[2] The fertile valley afterward called by the Spaniards "La vega real."

[3] Coanabó was a Caribbee by birth and the cacique of the rich province known to the Indians with the name of Mangana, located in the interior of the island.

[4] The captain of this detachment was a young and daring hidalgo named Alonso de Ojeda, who was a native of the city of Cuenca, Spain, and started with only fifteen armed soldiers, at the beginning of January, to find the famous gold mines of Cibao. He returned a few days after with the news that there was, in reality, an abundance of gold in that region. He had been a bold warrior in the recently-terminated war against the Moors of Granada, of whom the following feat of courage and intrepidity is related:—

It took place in the tower of the Giralda, at Seville. To entertain Queen Isabella, in whose company he was as an officer of the guard during her visit to that tower, and to give proof of his courage and agility, he, armed and accoutred as he was at that moment, mounted on a great beam which projected in the air twenty or twenty-five feet from the wall of the tower, and at such a great height from the ground below, that the people in the street looked like dwarfs. Along that beam he walked briskly, and when at its extreme end he stood on one leg, lifting the other in the air; then, turning nimbly round, he returned in the same way, unaffected by the giddy height. Reaching almost the other end of the beam, and close to the wall of the tower, he stood with one foot resting on the beam, placed the other foot against the wall, and threw an orange he carried in his pocket over the summit of the figure Giralda, at the top of the tower.

He brought with him specimens from the different parts, that is to say, from the sand of the rivers and its banks.[1]

"It is generally believed that by digging as we know how, the gold will be found in greater compact masses, for the Indians neither know how to dig nor have they the means of digging the ground more than to a hand's depth.

"The other captain, who went to the other place called Niti,[2] returned also with news of a great quantity of gold in three or four localities, of which he likewise brought specimens with him.[3]

"Thus, surely, their Highnesses the King and Queen may henceforth regard themselves as the most prosperous and wealthy sovereigns on earth, because never yet, since the creation of this world, has such a thing been seen or read of. On the return of the ships on the next voyage, they certainly will be able to carry back such a quantity of gold as will fill with amazement all who hear of it.[4]

"Here I think I shall do well to break off my narrative. And I believe that those who do not know me, and hear of these things that I relate to you, may consider me prolix and somewhat an exaggerator, but God is my witness that I have not exceeded by one iota the bounds of truth."

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[1] One of those specimens was a nugget that weighed nine ounces.

[2] This second detachment was under the command of another young and fearless hidalgo called Ginés de Gorbalán, who was sent back to Spain by Columbus right after his return from this expedition to Niti, as a witness of the marvelous richness of the island of Hispaniola. He took with him, to Spain, the large nugget of gold which Alonso de Ojeda had found in his exploration of the mountains of Cibao.

[3] These specimens were fewer and of less value than the others, thus proving that the region called Niti was not so rich in gold as Cibao.

[4] Dr. Chanca in my opinion was admirably sagacious, for what he predicted here in this important historical document, written at the beginning of the year 1494, was realized but a few years after, when the Spanish galleons, loaded with the gold and silver of the New World, incited the avarice of men of other nations, who did not hesitate to become piratical adventurers—euphemistically called buccaneers—in order to rob the Spanish properties in America, both on land and upon the sea.

THE ORIGIN OF THE SO-CALLED ATLANTIC ANIMALS AND PLANTS OF WESTERN NORWAY

By LEONHARD STEJNEGER

CONTENTS

I. INTRODUCTION

The present essay is an attempt to account for the existence in western Norway of a complex association of plants and terrestrial animals not found elsewhere in Norway except as manifest peripheral radiations from a secondary center of distribution, which embraces the coast between Stavanger and Kristianssund.[1] These animals and plants display an unmistakable relation to a similar biota strongly developed more particularly in Scotland and northwestern Ireland, and it is here proposed to examine a little closer into this relation with a view to ascertain whether the connection is direct and genetic, or only indirect and due to parallel development. Because of the insufficiency of the material at hand as well as the unsatisfactory status of the scientific record, the inquiry only relates to a few selected forms and is primarily undertaken to serve as a foundation for a theory as to the origin of the biota which has received the somewhat unfortunate appellation "Atlantic" and to

[1] This stretch of the coast of Norway has no convenient distinctive name of its own. The Norwegian word "Vestenfjelds" is not exclusive enough, nor is "Vestlandet," both terms embracing much more of the country to the south of Stavanger as well as the interior fjord districts east to the watershed. It is often called "the northwestern fjord district," but "northwestern" is to some extent misleading and the term is cumbersome. In this paper when speaking of "west Norway" and "western Norway" I mean this coast strip between Buknfjord, in the south, and Trondhjemsfjord, in the north, or roughly between 59° and 63° north latitude.

incite further studies of the faunas and floras involved from the standpoint of this theory, in order that its merits or demerits may be thoroughly tested. The essay deals principally with biogeographic problems, but where it has been found necessary to introduce morphological matter in order to prove relationship, such questions are also discussed. Certain geological considerations which could not well be avoided have been set forth with due reserve, and in the most tentative manner.

In the course of his investigations the biogeographer when studying the dispersal of certain biota and their immigration into other regions is frequently facing facts which compel him to assume that the animals and plants have crossed territory now covered by the sea. The first question he then asks himself is whether there is any geological evidence in support of his theory. If not a geologist himself, he begins to study the geological literature. It has been my experience that whatever view I have taken, or from whatever side I have been viewing a question of this nature, I have always been able to find a geological theory and a geologist quotable in defence of my contention. Do I need a land connection in a certain place, there is always some geologist at hand willing to lift the ocean's bed thousands of fathoms even in comparatively recent times. If the views I have advanced concerning the biotic dispersal do not commend themselves to my fellow student, he may with equal confidence search the geological literature and sustain his opinion with quotations diametrically opposed. It is comparatively seldom that we are able to find paleontological evidence, and even then we are not always safe. Under these circumstances it seems to be the wisest course for the biogeographer to abide by the results to which he is led by his study of the present geographical distribution. If he can show then that his theories are not inconsistent with accepted principles and with the general outline of conservative geological opinion, he must remain satisfied. The details and the controversial points he may safely leave out, unless his own researches bear directly upon the latter.

The immigration of the biota of the Skandinavian peninsula after the great glacial period had destroyed most of the higher life previously existing there was comparatively early recognized by Swedish naturalists as having taken place along two different routes, viz., from the south across one or more Baltic land connections and a northeastern one over Finland and northwestern Russia. These two elements, the one descended from the biota of the central

European lowlands, the other composed of Russo-Siberian types, were easily recognized and accounted for. As the flora of Norway, especially the western part, became better known, a third element obtruded itself, namely, the one which Professor Axel Blytt called "the Atlantic group" of plants. These plants[1] he suggested had come from the "south and southwest," but from the context (*Forhandl. Vidensk. Selsk. Kristiania,* 1893, II, No. 5, p. 11) it is evident that he means the Danish peninsula, Jutland, the direction "south and southwest" being relative to his place of residence, Kristiania, not to western Norway.[2] Altogether the Norwegian botanists have been very vague in their statements regarding the origin of this flora, even Dr. Jens Holmboe, as late as 1903 (*Skr. Vidensk. Selsk. Kristiania,* 1903, I, No. 2, p. 201) speaks of the "*Ilex* flora" having "immigrated across the sea from the southwest," and of *Calluna vulgaris* he says (p. 213) that it is most reasonable to conclude that it has "immigrated across the sea," but by referring to the possibility of it crossing "an arm of the sea as broad as the Skagerak between Jutland and the south end of Norway" he plainly indicates the way he thinks it has come. The Swedish botanist, Dr. R. Sernander (*Skand. Veget. Spridningsbiol.,* 1901, pp. 414–416), is more direct, for he speaks (p. 416) of the *Ilex*-plants coming "clear across the Skagerak."[3] Most of the botanists, however, have held that the west Norwegian flora has wandered step by step and slowly from south Sweden to southeastern Norway and thence along the south coast past Lindesnæs and Stavanger to Kristianssund and the Trondhjemsfjord. As this question has been discussed voluminously and in great detail by the botanists, and as from the standpoint of the terrestrial animals it has received but little attention from the zoologists, the latter, as a rule and without questioning, have accepted the view of the majority of the botanists.

In February, 1901 (*Amer. Natural.,* XXXV, pp. 109–112) I had occasion to publish my theory that a certain number of animals

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[1] For a definition of this group see further on p. 484.

[2] In his original paper on the immigration of the flora of Norway (*Nyt Mag. Naturvid.,* XXI, 1876, p. 349) Blytt hints at the possibility of the "Atlantic" flora having come to western Norway from a hypothetical "North Sea land," but because of the deep water along the west coast and of the Norway channel he thinks "it would be over bold to assume a land connection between our west coast and such a North Sea land."

[3] And even under this supposition he is surprised that they can have reached as far north as they have, "past Lindesnæs degree by degree of latitude up to Kristianssund" (p. 415).

such as the red deer, the tundra reindeer, the variable hare, the ermine, the Norwegian lemming, the ptarmigan, etc., invaded western Norway from Scotland on a land bridge across the North Sea. There was no opportunity then for going more into detail, but my reference to Sharff's map (Hist. Europ. Fauna, 1899, p. 156) roughly indicated this land connection as affecting only the *northern* portion of the North Sea. Since then I have occasionally referred to this theory in papers on the geographical distribution of the dippers (*Cinclus*),[1] and on the identity of the so-called Celtic horse (*Eqvus celticus*) with the west Norwegian pony.[2]

At the time of first making this theory public I also suggested that a certain element of the west Norwegian population "which holds the extreme west coast to almost the identical extent as the red deer" came to western Norway by "the North Sea bridge, either yet intact or only broken to the extent of furnishing stepping stones."[3]

This theory of mine respecting the origin of part of the west Norway fauna received considerable support from a theory bearing on the origin of the west Norwegian "Atlantic" flora propounded by Dr. Andreas M. Hansen in his remarkable book "Landnaam i Norge" (Kristiania, 1904). On pp. 293 to 298 he attempts to prove that these "Atlantic" plants which are now so characteristic of and mostly confined to the west Norwegian coast north of Stavanger are of "interglacial" age, that they came from the west, and that they survived the neoglacial stage[4] on a glacier-free border land skirting the western and northern coast of Norway.

Professor N. Wille has quite recently (1905) as will be noted more in detail further on (p. 486) accepted this theory for a portion of the so-called "Arctic" flora.

Hansen, however, does not mention the theory already published by me, which has so many points in common with his own. Alto-

[1] Smithson. Misc. Coll. (Quart. Issue), XLVII, pt. 4, 1905, p. 429.

[2] *Naturen* (Bergen), 1904, p. 166.

[3] Mr. Helliesen, curator of the museum in Stavanger, Norway, made a similar suggestion a few months later. In Stavanger Museums' Aarshefte for 1900 (published after May 9, 1901), pp. 57–60, he describes a paleolithic "kitchenmidden" from Jæderen, and concludes by saying: "From this oldest stone age people is probably descended the present brachycephalic race which is found especially in western Norway. It probably arrived in the country over the sea from Jutland or Scotland."

[4] By this term he understands the phase of the glaciations of the peninsula, which the Scandinavian glaciologists generally call the "second," or "last," glaciation. By "megaglacial stage" he designates their "first," or maximum, glaciation.

gether the question of a distinctly Scoto-Norwegian dispersal of the fauna has not been taken up for discussion until a year ago (1906) and then only with regard to the origin of the red deer in Norway.

II. The Red Deer

In calling attention to the case of the red deer which is confined to western Norway from Stavanger to Namsos (59°–65° north latitude) while entirely absent from the interior or eastern Norway, I indicated that it "doubtless forms a small-antlered race, or subspecies, of *Cervus elaphus*," but I did not name it, as our museum then did not possess a specimen of this form. My friend, Professor Einar Lönnberg has since confirmed its distinctness and called it *Cervus elaphus atlanticus* (*Ark. Zool.*, III, No. 9, 1906, p. 11).

In this article (On the Geographic races of red deer in Scandinavia) Lönnberg does not give a separate diagnosis of this form, but from the text the following distinctions may be gathered:

Swedish Deer (*C. elaphus* typ.).	Norwegian Deer (*C. atlanticus*).
Much larger.	"Much smaller size" (p. 3).
"Well-developed mane" (p. 3).	No well-developed mane.
Summer coat "dark reddish brown, almost chestnut, and the legs very dark sooty or blackish brown" (p. 3).	Summer coat "yellowish brown with tinge of grey and the legs much paler, slaty brownish grey" (p. 3).
Caudal disk "less pronounced . . . sometimes not much lighter than the flanks and although it is bordered by a darker shade towards the thighs this dark color never takes the shape of a black stripe" (p. 3).	Caudal disk "lighter, somewhat reddish yellow and bordered by blackish" (p. 3).
As a rule "larger skulls" (p. 3).	As a rule shorter skulls.
Nasals "transversely curved," "well visible, especially when the skull is seen from the side" (p. 5).	Nasals "much flatter so that they are when the skull is viewed from from the side, hardly, or not at all visible in front above the ends of the premaxillaries" (p. 5).
Nasals "as a rule decidedly longer," much less expanded and more convex posteriorly, the "combined greatest width of both nasals contained about 3 times (one specimen only 2⅞ times) in the length" (p. 5).	Nasals as a rule decidedly shorter, "much more expanded and less convex posteriorly" (p. 5); "width of both nasals . . . less than 2½ times in their length" (in hinds never more than 2¾ times) (p. 6).
Height of nose at the posterior end of the premaxillaries "exceeds 50 mm." (p. 7).	Height of nose "at the hind end of the premaxillaries does not attain 50 mm., but usually is less than 45" (p. 7).

"Antorbital vacuities much wider, as a rule 28 mm. or more"—the length (in hinds and young stags) 58–63 mm. (p. 7).	Antorbital vacuities much narrower, as a rule 19 mm. or less (21 mm. in one large specimen), the length (in hinds and young stags) 39–47 mm. (but in the very old specimen 55 mm.).
Orbital roof "more solid," "pierced by several foramina, none of which even attains half the size as that of the Norwegian deer" (p. 8).	Orbital roof "very thin and shows one comparatively very large foramen with a diameter of more than 10 mm.," sometimes considerably more (p. 7).

Several other differences are also noted, but the above are the principal ones.

Lönnberg's material consisted of five Swedish hinds and young stags and seven Norwegian hinds and young stags (p. 8) as well as one "very old and big stag" from Norway (p. 7).

In addition to this material he had the skulls of two adult stags (with five tines on each antler) from Invernesshire, in northern Scotland, which he thinks probably represent another independent subspecies "which suitably may be termed *scoticus*" (p. 11). With these he associates a female skull from Ireland in the Dublin Museum, though he intimates that there may possibly be important differences between the Irish and Scotch deer (p. 13). However, "as far as could be concluded from this single specimen the dimensions agree pretty well with those of the Scotch deer. Both are small-headed and short-nosed, with small antorbital vacuities and large foramina supraorbitalia as the Norwegian deer, but otherwise not so slender as that race." In these respects *Cervus scoticus* differs from the typical *C. elaphus* of southern Sweden. From the Norwegian *C. atlanticus* it differs, as alleged, by the skull being less slender. This greater robustness, according to p. 10, is shown in the greater width of the skull just behind the premaxillaries, in the greater zygomatic width, and in the greater height of the maxillary, the Scotch deer in these respects agreeing with the Swedish deer, though in the last-mentioned character the Irish specimen is said to be partly approaching the Norwegian deer (top of p. 13). The main difference from the latter, and consequent agreement with the Swedish deer, is found in the Scotch and Irish deer having the nasals less flattened and less straight.

As described by him, the Scotch-Irish deer is intermediate between the Norwegian and the Swedish deer.

The U. S. National Museum has recently acquired in exchange with the Zoological Museum in Kristiania (through Professor

Robert Collett) a splendid stag of the west Norwegian deer which fully bears out the distinctness of this form from the typical Swedish *Cervus elaphus*. At the same time, it shows that Lönnberg's material was not sufficient to establish the range of individual variation in the Norwegian deer, and, moreover, it most completely demonstrates the identity of the Scotch deer with that of Norway. The necessity for scrutinizing it more in detail is therefore obvious.

No. 143,179 U. S. N. M., an adult male, killed at Gloppen, Nordfjord, Norway (about 61° 45′ north lat.), on March 12, 1906, is consequently from the most typical and central part of the Norwegian habitat. It is a full-grown animal (pl. LXVII) with five points on one, and six on the other antler, though it is not very old as shown by the molars not being worn at all. The bez tine is a mere rudiment on one side, while on the other it is quite small, less than one third as long as the brow tine. The latter forms an obtuse angle of about 110° with the beam.

As might be expected, the skull is somewhat larger than those of the young Norwegian stags described by Lönnberg, the basicranial length being 341 mm. though not so large as his "very old and big stag" with the corresponding length of 352 mm.

The nasals are comparatively short and wide, though not excessively so. The ratio between "the combined greatest width of both nasals" and "the length of the nasals," the one selected by Lönnberg to represent that fact, is 1:2.71. It consequently lies between the extremes of the two Scotch stags, as measured by him (p. 10), namely, 1:3 + and 1:2.6 respectively, as well as between his ratios for the seven Norwegian young stags and hinds, viz., 1: 2.75 and 1:2.5.

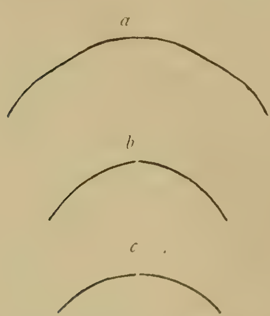

FIG. 124.—Diagram showing the curvature of the nasal bones of *Cervus atlanticus*, no. 143,179 U. S. N. M. Cross sections at three different points.

But—the nasals are *not* flattened, as they should be if that character were a valid one for the distinction of the Norwegian deer. On the contrary, as will be seen from the accompanying diagram (fig. 124) which represents the upper surface of the nasals in cross section at their widest part (*a*), at a point opposite the posterior end of the premaxillaries (*c*), and at a point halfway between the two other points (*b*), the roof of the nose in this individual is very much convex. Moreover, as will be seen in the photograph of the profile of

SKULL OF CERVUS ATLANTICUS, ADULT MALE. No. 143179, U. S. N. M. VIEW FROM ABOVE

SKULL OF CERVUS ATLANTICUS, ADULT MALE. No. 143179, U. S. N. M. SIDE VIEW

the skull (pl. LXVIII) the nasals, when viewed from the side, are visible in front above the ends of the premaxillaries, fully as well, in fact, as in the Irish hind figured by Lönnberg (p. 12, fig. 6). Nor is the outline of the profile perfectly straight, as described and figured in Lönnberg's specimens. There is a decided curvature both in front and behind, so that this Norwegian stag appears to suggest the same "tendency to 'Rammsnase,'" as the two Scotch skulls described by Lönnberg (p. 10), a tendency apparently not shared by the Irish hind and as a character in these animals probably of no value whatever.

The antorbital vacuities are described by Lönnberg in the Norwegian, Scotch, and Irish speciments as essentially of the same size and shape. In our specimen they are rather large.

The supraorbital foramina are very large, one 15 mm., the other 18 mm., thus agreeing with the other Norwegian skulls as well as with the Scotch and Irish.

The other characters relied upon by Lönnberg are those of relative proportions and can best be discussed after I have given the requisite dimensions.

Our specimen (no. 143,179) measures as follows:

	Mm.
Basicranial length	341
Distance from anterior tip of premaxillary to orbit	211
Zygomatic width at the posterior end of jugale	146
Width of skull just behind premaxillaries	69
Length of nasals (average[1])	122
Greatest width of both nasals combined	45
Vertical height of nose at the posterior end of premaxillaries	58
Length of upper molar series (socket)	109
Width of antorbital vacuity	28
Length of antorbital vacuity	56
Longest diameter of foramen supraorbitale (average[2])	16.5
Height of maxillary above the foremost molar	40
Height of maxillary above the foremost premolar	69
Distance from lower orbital rim to last molar	46
Antlers, inside distance between beams at base of subroyals	508
Antlers, distance from burr to farthest point	578

Unfortunately, there are hardly any individual measurements of his Swedish and Norwegian specimens in Lönnberg's paper, most of the dimensions given being maxima and minima of the series, except in a few instances, so that it is impossible to include them in a comparative table, or to reduce them to the unit of one of the

[1] Right 120 mm.; left 123.5 mm.

[2] Right 18 mm.; left 15 mm.

dimensions. With regard to the Scotch and Irish specimens more specific data are given, though in the case of the two Scotch specimens I have been obliged to assume that he always gives the measurements in the same order, so that those mentioned first are to be regarded as belonging to the one individual, and those given last to the other. From his text I have thus culled all the individual dimensions, adding those of our specimen. Whenever the length of the facial part of the skull, as expressed by the distance from the distal end of the premaxillaries to the orbit (the dimensions selected by Lönnberg) is given, I have reduced the others to percentages of it. In the following table the actual measurement is given above the fraction line, the percentage below it.

Comparative Measurements of Norwegian, Scotch and Irish Deer

	U. S. N. M. No. 143179. Norway. Adult Stag.	Hitteren, Norway. Very Old Stag.	Hitteren, Norway. Young Stag.	Hitteren, Norway. Young Stag.	Scotland. Young Stag *a*.	Scotland. Young Stag *b*.	Ireland, Hind.	Southern Sweden. Young Stag.	Southern Sweden. Older Stag.
Basicranial length	$\frac{341}{162}$	$\frac{352}{161}$	303	310	$\frac{311}{159}$	$\frac{319}{161}$	$\frac{301}{161}$	330	373
Tip of premaxillaries to orbit	$\frac{211}{100}$	$\frac{218}{100}$			$\frac{195}{100}$	$\frac{197}{100}$	$\frac{187}{100}$		
Zygomatic width	$\frac{146}{69}$				$\frac{139}{71}$	$\frac{143}{72}$	$\frac{135}{72}$		
Width of skull behind premaxillaries	$\frac{68}{32}$				$\frac{61}{31}$	$\frac{56}{28}$	$\frac{56}{30}$		
Maxillary height above anterior molar	$\frac{40}{19}$				$\frac{41}{21}$	$\frac{32}{16}$	$\frac{39}{21}$		
Maxillary height above anterior premolar	$\frac{69}{33}$				$\frac{60}{31}$	$\frac{60}{30}$	$\frac{55}{29}$		
Orbit to posterior molar	$\frac{46}{22}$				$\frac{42}{22}$	$\frac{45}{23}$			

The substantial agreement of all the critical dimensions of the Norwegian, Scotch and Irish deer selected by Lönnberg is demonstrated by the above table. These deer are all equally short-faced, as already pointed out by him, but it is so far from the Norwegian deer always being the slenderer, that the specimen in our museum has decidedly the broader snout, while as to the maxillary height two of its dimensions fall inside the maxima and minima of the Scotch and Irish specimens, while one even exceeds their maxima.

Among the less important characters Lönnberg mentions (p. 8) the presence in the Norwegian deer seen by him a small foramen on the lower jaw below the anterior premolar, which is usually absent in the Swedish deer.[1] It is present only on one side in our

[1] Lilljeborg, *Sveriges och Norges Ryggradsdjur*, I, Däggdj., II, 1874, p. 794, mentions already the absence of this foramen in the Swedish deer.

specimen, and I may add that it is plainly visible in Lönnberg's figure of the Irish hind (p. 12, fig. 6).

It seems thus pretty clearly established that the name *Cervus elaphus scoticus* is only a synonym of *Cervus atlanticus,* and that my supposition of the Scotch and Norwegian deer being of the same extraction and different from the central European stock (*Amer. Natural.,* XXXV, 1901, p. 110) has been amply verified.

With this conclusion it would seem that Lönnberg's subsequent criticism (pp. 15–17) of my theory, that the deer immigrated into western Norway over an ancient Scoto-Norwegian land bridge falls to the ground. At the same time his own centention, that it came from south Sweden with the "*Ilex*-flora" and has died out in the intermediate territory, becomes untenable. I agree perfectly with his proposition (p. 18) that "the red deer went the same way as the flora did," but in the present essay I hope to show that the flora with which the red deer arrived in west Norway did not come *via* southern Sweden either. In his discussion of my theory Lönnberg complains (p. 15) that I did not specify explicitly the period during which the immigration into western Norway took place and surmises that I meant it to have occurred in preglacial time because of my view that some "members of the older Oriental invasion," as one of which I regard the ancestor of *Cervus atlanticus,* "joined the preglacial Siberian immigration in France," but my statement (*Amer. Natural.,* XXXV, 1901, p. 109) about this immigration taking "place early, probably before the first great glaciation reached its maximum" clearly refers to its entering eastern Europe during the early stage when "neither ice nor water had yet shut off the passage north of the Caspian Sea" and not to the time when its most westerly projected members reached Norway. I deliberately refrained from mentioning any specific time, because the Scandinavian geologists had not reached an agreement as to whether there has been one glacial epoch or several, or in the latter case whether the last glaciation in western Norway extended as far as the former, and in the paper referred to there was no opportunity to enter into any lengthy discussion of these questions. Under those circumstances I was very careful to avoid the word *interglacial* since in my opinion the invasion over a Scoto-Norwegian land bridge is a biologic occurrence which need not be affected either by the acceptance or the rejection of an interglacial theory.

After having stated "as an established geological fact that at the time of the first great glaciation the existence of any terrestrial

organic life in Scandinavia was utterly impossible "[1] and that "probably the situation was just as bad during the second glaciation," Lönnberg proceeds as follows: "In addition to this must be mentioned that from the time of the first glaciation and until the ice had almost completely melted away in the Ancylus epoch there was not only not a land connection between Scotland and Norway but the southern part of Scandinavia (including Denmark) was more depressed than it is now and thus the North Sea and Skagerak formed a barrier against the distribution of terrestrial mammals from Scotland to Norway even more effective than it is in the present day." Apart from a most decided reservation against the theory of the utter extinction of all higher terrestrial life in the entire Scandinavia during the two glaciations, and more especially during the second, being called "an established geological fact," since there is a growing opinion among glaciologists that there was a considerable area of ice-free land in western and northern Norway during the latter, I must insist that the question of a Scoto-Norwegian land bridge does not involve the rise of land in the southern part of the North Sea, Denmark, or southern Scandinavia. The land bridge in question connected much farther north, on the west coast of Norway certainly not south of 59° north latitude, while on the east coast of Scotland only the land north of 56°, including Shetland in the north and the Hebrides with northern and western Ireland in the west is included. It may be said in general that an interpretation of the biotic history of the glacial period in western Norway must always be defective if it is taken for granted that what happened there during that age was a mere synchronous repetition of what happened in the Baltic and in southern Sweden.

The other biotic and geologic considerations involved are treated of elsewhere in this paper and need not detain us here, but I wish to point out in this connection that my theory of the Scoto-Norwegian dispersal would not have been invalidated even if Lönnberg had been correct in considering the Scotch and the Norwegian deer subspecifically distinct. According to his view the former has more characters in common with the Central European deer, the

[1] Compare this with Kobelt's view in Die Mollusken der Palaearktischen Region, 1897, pp. 152–158.

The question whether the megaglacial period in Scandinavia was so excessively severe as indicated by Lönnberg I have barely touched upon in this essay, as it does not necessarily affect the main proposition I am defending. Probably everybody is agreed that it was severe enough to preclude the possibility of the majority of the biota here considered from having survived in Norway since preglacial times.

west Norway form being the more specialized type. Such a state of affairs would be quite consistent with my theory of the latter being the last link in an evolutionary distributional chain: Continental Europe—Scotland—Norway. Having been isolated from the Scotch ancestor for certainly more than ten thousand years, there would be nothing surprising if the Norwegian deer had evolved characters of its own, and it is even possible that the apparent tendency to flattened nasals in the latter is attributable to this long segregation.

III. The Celtic Horse

During the meeting of the Edinburgh Royal Society, on December 1, 1902, Professor J. Cossar Ewart read a paper "On a New Horse from the Western Islands, *Equus caballus celticus*" (*Nature,* LXVII, January 8, 1903, p. 239). It was described as a small pony, the principal character of which is that it agrees "with the asses and zebras in having no callosities on the hind legs." It was said to be "found in Iceland, Færœ, Barra, and other small islands of the Outer Hebrides, also in Connemara," northwestern Ireland. The inference from the brief communication is that the Celtic horse is an exclusively west European form as compared with the Arab and other eastern horses.

The color description, yellow dun with black fetlocks and stripes or fragments of stripes on back, legs, etc., at once called to my mind the west Norwegian pony, the so-called "Fjordhest" which is the predominant race of horse along the entire western coast of Norway, on the outer islands as well as in the fjord districts, while an entirely different horse, the "Dœlehest," or Gudbrandsdal horse occupies exclusively the interior and eastern part of the country. The almost identical distribution of this fjord horse with that of the west Norway red deer suggested a similar origin, and consequently I began to gather material for a further study of the question. As usual, I found the literary record very defective. The various races or species of recent horses were either treated from the osteological standpoint alone or from their outward characters alone, such as form, color, size, etc. It was also a surprise to find that a character as important as the horny callosity, the so-called "chestnut" on the hind legs which formerly has been held to be even of generic importance in separating the genus *Eqvus* from *Hippotigris* and *Asinus,* the zebras and asses, has been overlooked by almost all authors. Nor did I find in the literature any indication to what extent

this horny callosity is transferred to the hybrids between *Eqvus* and *Asinus*. On this latter point I was able to make observations on hundreds of mules to the effect that the callosity is nearly always transferred to the progeny. This is important, since it renders it almost certain that in hybrids among the more closely allied species within the restricted genus—or subgenus—*Eqvus*, the callosity will always be found, if possessed by one of the parents. In these days of universal crossbreeding of the domestic races for their "improvement" it has become very difficult to find a country horse of absolutely pure race except in the remotest part of mountain districts or regions otherwise difficult of access.

Fortunately, Tscherski in his excellent work on some fossil Asiatic horses[1] gave a clew by carefully describing both the external and the osteological characters of the "Tarpan," a small horse which until the middle of the last century was found wild in the steppes of south Russia. Not only did the tarpan lack the callosity on the hind legs, but in size and color also did it tally with the Celtic and the west Norway pony, and what is equally to the point, the skull "in its essential relative dimensions agrees with those of the Iceland horses."

The result of these preliminary investigations I summarized in a paper entitled "Den celtiske pony, tarpanen og fjordhesten," which was published in the June–July number of *Naturen* (Bergen), 1904, in which I urged the specific distinction of *Eqvus celticus* and suggested the extreme probability that all three horses mentioned, viz., the Celtic pony, the Russian tarpan, and the west Norway fjord horse belong to this species, and the various heavy European horses to another species which must stand as *Eqvus frisius* (Boddaert).[2] I also suggested that the fjord horse came to west Norway from Scotland as a descendant of the Celtic pony.

About the same time Professor Ewart published a more detailed

[1] *Mém. Acad. Sci. St. Pétersbourg* (7), XL, No. 1, 1892, pp. 257–383.

[2] Of which Fitzinger's *Eqvus robustus* and Nehring's *E. caballus* var. *germanica* are synonyms.

The Linnean *Eqvus caballus* is a collective name without indication of type specimen, of course. The restriction of the name, as practiced by the first revisor, must, therefore, be accepted, and this restriction it appears was undertaken by Fitzinger, in 1858, who reserved the name *E. caballus* for the group having the Arab for type. Now to restore the name to the horse occurring in eastern Sweden is clearly impracticable, as no well-defined form is restricted to that country and, moreover, would be contrary to all accepted nomenclatorial codes. The relationship of Fitzinger's *E. velox* to his *E. caballus* is one of the many unsettled questions in European hippology.

account of his new pony under the title "The multiple Origin of Horses and Ponies" (*Trans. Highl. Agric. Soc. Scotland* (5), XVI, 1904, pp. 230–268; abridged in *Nature*, LXIX, 1904, pp. 590–596). In this paper, which had not come to hand when I wrote mine, the characteristics of *E. celticus* are more elaborated, especially what he terms the caudal fringe, or "tail-lock," of the winter coat, a heavy covering of long hair at the root of the tail above. This he regards as the result of adaptation to a subarctic environment. Hence, it seems to me, its presence or absence in allied forms or varieties does not carry much weight as proving or disproving relationship. About the mane he says that it "is made up of a mesial portion (nearly twice the width of the entire mane in an Arab) consisting of strong dark hair, and of two lateral portions the hair of which are lighter and finer." He also mentions a flat-nosed variety in the Færœs, the Hebrides and in Shetland which, except in color, shape of the head, and occasionally the form of the hind-quarters, closely agrees with the typical Celtic pony. Some of these flat-nosed ponies are of a foxy-red color, others are dark brown.

A very important section of his paper is devoted to "The Norse Horse (*Equus caballus typicus*)." This he regards as having "centuries ago acquired the rank of a distinct species, or at least a well marked natural variety." "A typical specimen of the Norse variety is of a dark yellow-dun colour, with black 'points,' and a nearly black mane and tail" (p. 264; p. 595). "The space between the orbit and the nostril is relatively longer than in the Celtic pony" (p. 265; p. 596), it is consequently a longer-faced animal, in connection with which statement it is noteworthy that the forehead is said to be "not particularly wide." Several more differences are noted, but it is sufficient here to mention the last one given, viz., that the Norse horse differs "in having a complete set of ergots and chestnuts" (p. 265; p. 596); it has consequently the horny callosities of *Eqvus caballus*. Professor Ewart does not give the exact distribution of the Norse horse, but he mentions expressly that it occurs in the northwest of Scotland, and that "there is little doubt that it was introduced into Scotland from Scandinavia about the end of the eleventh or beginning of the twelfth century" (p. 264; p. 595). He finally concludes his comparison of the two types with the emphatic statement that "it is inconceivable that the Norse variety could . . . be regarded as an offshoot from the Celtic pony"!

Compared with my own conclusion, given above, that the Celtic pony and the west Norwegian horse belong to the same species, it would seem that Professor Ewart and I have come to absolutely diametrically opposite results. Yet, it only seems so, for I am willing to subscribe to every word of his conclusions with regard to the Norse horse he is speaking of. The explanation is, of course, that he does not refer to the west Norwegian horse I have been treating of, the true "fjordhest." His Norse horse is the "dœlehest," and these two I regard as specifically distinct.

There is nothing in Ewart's paper to indicate that there are two very distinct types of native horses in Norway, and yet no fact is better established. One of these was originally, and is even now to a great extent, confined to the west coast, the other to the interior valleys and the lowlands of the eastern part of the country (hence the distinctive names of fjord-horse and valley-horse). The latter being the heavier horse has in later years been introduced into the western districts in order to "improve" the coast race, and consequently numerous hybrids are now found in west Norway.

It was my good fortune to be able to examine a large number of typical fjord-horses during a visit to Bergen in 1905. I was very apprehensive lest the admixtures of foreign blood might have nearly obliterated the pure breed, but fortunately my fears were unfounded, there were enough unmixed, unimproved horses left.

To be brief and to the point, I found the fjord-horse to possess all the essential characters of *Eqvus celticus*, as given above, in which it differs from Ewart's "Norse horse." Its normal color is a pale buff, but also often mouse-gray; uniform dark brown specimens such as Ewart describes in his flat-nosed varieties of the Celtic pony, are also seen. The mane is bicolored, light on each side with a broad, black central part, exactly as described by Ewart in the typical Celtic; the tail is also only mixed with black. All these points are fairly well shown in the photograph (pl. LXIX, 1). The winter coat, especially in the animals of the outer coast which often, particularly in former times, have to pass the winter in the open air without much shelter, is rather long with long forelock and beard, and long hair at the base of the tail. The forehead is broad and the facial portion of the head short. The legs are rather slender and the hoofs small. And last, but not least, *the typical west Norwegian pony lacks the hind chestnuts,* the horny callosities on the hind legs, the main criterion of *E. celticus!* I examined a large number of farmers' horses in the city of Bergen on the regular

FIG. 1.—NORWEGIAN FJORD HORSE, EQVUS CELTICUS, IN BERGEN

FIG. 2.—NORWEGIAN FJORD HORSE, LOFOTEN VARIETY. MOUNTED SPECIMEN IN THE BERGEN MUSEUM

market days and was surprised to find how many were without a trace of these burrs. In the majority of the animals there were small, often very minute vestiges of callosities, and it was interesting to note how closely their smaller or greater size corresponded to the greater or lesser approach of the other characters to the type of the pure-bred horse. These were all common farm horses without pedigree, and the amount of admixture of foreign blood was a matter of conjecture. Only in one instance was I able to examine an *authentic* hybrid between alleged pure-bred parents. The specimen is now mounted in the Bergen Museum. It is a mixture of Nordfjord horse and Gudbrandsdal horse, and the longest diameter of the posterior callosities measures 23 mm.

In the museum at Bergen I found another highly interesting specimen which has a decided bearing on the question. I am, therefore, going to give some details derived from an examination, for the privilege of which I am greatly indebted to the curator of the division of vertebrates, Mr. James A. Grieg.

The specimen is one of the last survivors of a white variety of the fjord-horse formerly more common in Nordland and, more especially, on some of the Lofoten islands. A photograph of the mounted specimen (pl. LXIX, 2) shows what an extraordinarily long-haired creature it is, exceeding that of the Celtic pony figured by Ewart (p. 249, fig. 34; p. 593, fig. 5), the hair being distinctly curly, especially on the legs. Needless to say, *the hind chestnuts were absolutely lacking!*

The most interesting part of this specimen, however, is its skull. Unfortunately, we have no description of any skull from the type locality of *Eqvus celticus*, but Ewart's hints as to the relative width of the forehead and the length of the facial portion of the two horses indicate an agreement with the results which I have obtained.

The following measurements of the skull of the Lofoten horse are only those regarded by Tscherski as of particular importance.

Tscherski's number	Dimensions	Millimeters
1.	Basicranial length	456
3.	Distance from the middle of the occipital crest to the outer rim of the orbit at the point of greatest cranial width (Hintere Augenlinie, Nehring)	187
4.	Distance from the point between the median incisors to the outer rim of the orbit at the same point (Vordere Augenlinie, Nehring)	352
5.	Distance from the point between the median incisors to the nearest point of the anterior rim of the orbit	295

15.	Distance from anterior margin of foramen magnum to the vomerine notch	118
16.	Distance from vomerine notch to posterior margin of the bony palate	99
30.	Greatest width between the outer margins of the orbits	210

Tscherski relies primarily upon the three cranial indexes elaborated by Nehring and himself for the expression of racial characteristics of the horses. They may be explained briefly as follows:

(1) The *Frontal Index* (Stirnindex, Tscherski; Index I, Nehring) expresses the proportional relation of the length of the skull to its width. It is obtained by dividing the basicranial length (dimension 1 of the above table) by the greatest width of the cranium at the orbits (dimension 30) and multiplying by 100. Skulls with a frontal index less than 227 are regarded as brachycephalic (breitstirnig, Tscherski), those with an index between 227 and 240 mesocephalic (mittelstirnig), and those above 24 dolichocephalic (schmalstirnig).

(2) The *Orbital Index* (Augenindex, Tscherski; Index III, Nehring) expresses the relation of the length of the facial part to the cerebral part of the skull by dividing dimension 4 by dimension 3 and multiplying by 100. The greater the resulting figure, the more long-faced is the horse and *vice versa.* This index is less reliable than the next which is intended to express the same relation, but it is utilized because only by it Nehring's numerous measurements become available for comparison, as his tables do not include dimension 5. Skulls with an index less than 190 may be regarded as short-snouted, with more than 190 as long-snouted.

(3) The *Facial Index* (Facialindex, Tscherski, p. 278) expresses the length of the snout by reducing the distance between orbit and tip of snout (dimension 5) to a percentage of the basicranial length. Tscherski does not state where he draws the line between short-snouted and long-snouted horses, but 65 or 65.5 probably expresses his idea (see p. 278).

These indexes in the Lofoten skull may be tabulated as follows:

Frontal index	217
Orbital index	188
Facial index	64.7

It will be seen, consequently, that this west Norwegian pony belongs to Tscherski's "small" horses (having a basicranial length of less than 460 mm.); that it is exceedingly brachycephalic; and that both according to the orbital and the facial indexes it is short-

snouted. This agrees substantially with the corresponding feature of the Celtic horse which, according to Ewart, has a broad forehead and a short snout.

It is interesting to note that the temperamental traits characteristic of the Celtic pony, viz., "keenness and speed, staying power and agility" (Ewart, p. 254) are the very ones attributed to the Norwegian fjord-horse.

It is at present impossible to decide whether the Celtic pony of western Norway came to that country in the wild state or domesticated.[1] But in either case, from what is now known of its geographic distribution, it must have come from Scotland. That it should have arrived from the southeast of Scandinavia with the "oak-flora," or with the dolichocephalic Teutonic race of man seems incredible, while the "dœlehest" unquestionably came with them that way. Ewart's ingenious explanation of certain characteristics of the Celtic horse and *his* (*i. e.,* eastern) Norse horse as indicating the latter to be a member of the forest fauna, the former of the Steppe fauna (p. 263; p. 595), or as I should prefer to say, the heath or barren-ground fauna, is highly suggestive in this connection.

IV. Other Species of Mammals

It will be remembered that my theory of an invasion of western Norway from Scotland by those members of the older, or "first" Siberian invasion which had been able to penetrate so far westwards before the final disappearance of the Scoto-Norwegian land bridge, extended to the whole assemblage called "the Arctic fauna" by Sharff in his valuable book on "The History of the European Fauna." I also included the red deer, as already discussed above in detail, and the Norwegian lemming (*Lemmus*

[1] I have already (p. 461) alluded to the fact that I suspect a certain element of the population of west Norway, whose distribution is nearly identical with that of the red deer and the Celtic pony, of having arrived there from Scotland practically at the same time as the "Atlantic" biota and over the same land bridge. In Scotland the presence of a similar type during the stages following the megaglacial climax is also known. That this element of the Norwegian population may have arrived there during "interglacial" time is admitted by Hansen (Landnaam i Norge, 1904, pp. 299–300).

As for the domestication of the horse it is now regarded as conclusively proven by Piette that it was accomplished "during the late Pleistocene epoch" (*Nature,* November 29, 1906, p. 108). There would then seem to be a possibility that the people alluded to may have brought the pony with them in a domesticated state.

lemmus) which Scharff considered as belonging to the [second] Siberian invasion. It is characteristic of the past and present distribution of these so-called "Arctic" animals that besides Norway they inhabit Great Britain and Ireland, the Alps and the Pyrenees, or have been found fossil in these countries and south of these mountains. Species which at the present day *also* inhabit extensive areas in the Arctic regions to the east of Scandinavia may have entered this peninsula from the east and north over Finland, in which case the Scandinavian species would be of dual origin. Similarly, species *also* living to the south and southeast may have entered southern Sweden shortly after the recession of the ice cap and spread northward. Thus a triple origin even is conceivable, as members of the same species may have come by all three routes. Whether we may be able to verify this multiple descent in the animals now inhabiting the peninsula, depends in each individual case upon the degree of plasticity of the parental form and also upon to what extent the members of the various invasions have been able to interbreed *after meeting again* on Scandinavian soil. No critical examination of the fauna with this particular object in view and based upon sufficient material has ever been attempted. There are plenty of hints, however, in the literature of such multiple origin of several of the species involved. Thus Nilsson, in his Skandinavisk Fauna, Däggdjuren (2 ed., 1847, p. 444) refers to several Swedish forms of *Lepus timidus* and to the possible distinction of the north Russian *Lepus variabilis* as a separate form.[1] Barret-Hamilton recognizes two Scandinavian forms of squirrel (*Sciurus vulgaris; Proc. Zool. Soc. London,* 1899, p. 6). There are also indications that *Mus sylvaticus* in Scandinavia may be of multiple origin,[2] and similar hints are plentiful with regard to many of the other micromammalia.

The scientific record of these is very incomplete as yet, but in a

[1] Barrett-Hamilton, *Proc. Zool. Soc. London,* 1900, pp. 88–91, refers to two of Nilsson's hares as *Lepus timidus* and *Lepus timidus collinus,* apparently considering the latter equivalent to the supposed larger northern form represented by the two large north Russian skulls examined by him. In this I think he is mistaken, for Nilsson expressly says that his *Lepus borealis,* with which he synonymizes his earlier *L. borealis collinus* is a smaller form than his *L. borealis campestris* (= *L. canescens*). The latter is from southern Sweden however. The large north Russian form, possibly extending into northern Sweden, should probably stand as *Lepus timidus variabilis.* See also Lilljeborg, *Sveriges och Norges Ryggradsdjur,* 1, Däggdj., 1874, pp. 420–422.

[2] Barrett-Hamilton, *Proc. Zool. Soc. London,* 1900, p. 405.

few cases enough is already known to indicate the probable meaning of the facts thus far recorded. Among these the case of the red-backed mice of the subgenus *Evotomys* is the most illuminating. In 1900 Gerrit S. Miller, Jr., published a preliminary revision of the group (*Proc. Washington Acad. Sci.,* II, pp. 83–109) based on 301 specimens from the regions with which we are here concerned. In northern and western Europe he distinguishes 10 forms belonging to three separate sections, viz.:

(*a*) *E. rutilus* which inhabits Arctic Asia and Europe west to Tromsœ, in Norway.

(*b*) A second section consisting of three allied but geographically disconnected species:

(1) *E. norvegicus,* from Norway north to Saltdalen (specimens examined, however, with one exception, all from Bergen Stift);
(2) *E. nageri,* from the Alps; and
(3) *E. vasconiæ,* from the Pyrenees.

(*c*) The third section embracing the species *E. hercynicus* (=*E. glareolus* Auctorum), with five geographically connected subspecies, as follows:

(1) *E. hercynicus hercynicus,* from Germany;
(2) *E. hercynicus helveticus,* from the lowlands of Switzerland;
(3) *E. hercynicus rubidus,* from the coast countries bordering the North Sea on the south;
(4) *E. hercynicus brittanicus,* from England and Scotland; and
(5) *E. hercynicus suecicus,* from eastern Sweden.

The distribution of the *nageri*-group (*b*) strongly suggests that of *Lemmus lemmus,* the variable hare, the reindeer, the ptarmigan, and several of the other animals of the same fauna, while the *hercynicus*-group (*c*), in turn, coincides with a large assemblage of species which entered Sweden from the south and also extended into non-boreal Britain. The only serious deficiency in the range of the *nageri*-group, as known to Miller in 1900, was its absence in Great Britain. That this discrepancy was only due to the imperfect status of the European faunal record was shown three years later by Barrett-Hamilton (*Proc. Irish Acad.,* XXIV, Sec. B, pt. 4, September, 1903, pp. 315–319) who described the new species *Evotomys skomerensis,* from a small island off the southwest corner of Wales, as "closely related to *Evotomys norvegicus* Miller, of Norway, *E. nageri* (Schinz) of the Alps, and *E. vasconiæ* Miller, of the Pyrenees," and "almost indistinguishable from those of

Boreal Europe." He suggests finally that "we may yet find amongst the Welsh Mountains further colonies of these Boreal Voles," and I might add that I would not be surprised if they also were to be found in the northern highland of Scotland.

The invasion of the ancestor of *Evotomys norvegicus* into Norway from the west is thus a distinct zoogeographical probability.

Were the various forms of the common field vole (*Microtus agrestis*) to be worked up with as ample material and painstaking skill as the red-backed mice, it is probable that parallel and equally suggestive results would be obtained, since there are enough indications pointing in that direction. But much collecting must be done in many places before anything reliable can be accomplished.

There are some points in the distribution of two of the mammals already mentioned to which I would call special attention, viz., the lemming (*Lemmus lemmus*) and the reindeer (*Rangifer tarandus*). They are now chiefly inhabitants of the mountain plateau of the Scandinavian peninsula, the former extending from southwestern Norway to Russian Lappland but not reaching east beyond the White Sea, the latter at the present time chiefly confined to the Norwegian fjells south of Trondhjemsfjord, while a small herd of wild reindeer is still found in West Finmark. Both animals show a decided western distribution in the southern part of the peninsula.

The range of *Lemmus lemmus* is such that there is no probability of a multiple origin. The fact that it is not found east of the White Sea precludes its having come into Scandinavia from the northeast. Its fossil history, on the other hand, speaks against it having entered from the south.[1] Furthermore, it has been found fossil at the base of the Alps and in British pleistocene deposits, and remains of lemmings of the Norwegian type have recently been found by Dr. Gadow in a cave in Portugal. The latter find shows pretty conclusively that this species belongs to the "first Siberian" invasion.

The wild reindeer (*Rangifer tarandus*), on the other hand, has almost certainly come into Scandinavia by several different routes. One form entered from the south and is now found fossil only in

[1] Winge has recently shown (*Vidensk. Meddel. Naturh. For. Kjöbenhavn*, 1904, p. 223) that the record of lemming from late glacial deposits in Denmark is erroneous. It is interesting to note that the ermine, or stoat (*Putorius ermineus*), another of the "Arctic" animals, is likewise absent in these deposits. Professor N. O. Holst, in a recent letter (January 22, 1907), informs me that these species have not been found fossil in Scania either. I may add that the polar fox (*Canis lagopus*) also appears to be absent.

southern Sweden. Another probably came from the northeast over Finland and northwestern Russia, the last remnants being found in a small herd in West Finmark. Finally, the distribution of the fossil remains of the barren-ground form in Ireland and Britain and the occurrence of this form in Norway make it probable that this species *also* reached the latter country from the west. It will be noted that I use very vague expressions. The fact is that no critical studies of the various "herds" in this region and of the fossil remains from the adjacent countries have ever been made[1] It is always taken for granted that the Scandinavian reindeer is a homogeneous, monophyletic species, and even the skeletons and skulls of tame Lapp reindeer have been used for comparison without reservation, notwithstanding the possibility that the latter *may* represent a fourth, probably Siberian race comparatively recently introduced by the Lapps. The whole question, moreover, has been made extremely intricate by the mixing and hybridizing of the "herds." Thus the northern, or Finmark, herd has been in contact with the Lapp tame reindeer for centuries and is probably greatly mixed in consequence. Of late years immense flocks of the same kind of tame reindeer have been introduced on the western plateau of southern Norway with the result that pure-bred wild reindeer are getting to be scarce.

Finally a word about the mammoth (*Elephas primigenius*) which plays such a conspicuous rôle in pleistocene history. A single small molar of this animal has been found among the gravel in the bed of a stream at Skjervasæter, in Vaage (Brögger, Norge i 19 Aarhundr., 1, 1900, p. 23, fig. 24), the only find of this kind in Norway. Brögger regards this as evidence of an ice-free interglacial

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[1] Hansen (Landn. Norge, 1904, p. 291) speaks of the reindeer found fossil in south Sweden as resembling the "American variety" [woodland caribou?] and not their "relatives farther north" in Scandinavia. Professor Holst, however, writes me as follows: "The antlers of the reindeer are regarded here [in Stockholm] as useless in the diagnosing of any definite varieties. Such horns are not seldom found in Scania *under* the peat in the late-glacial clay or 'gyttja.' The museum of the Swedish Geological Survey possesses a multitude of such horns (cast off) and I myself have collected a considerable number. I have been able to demonstrate that cylindric and palmate forms occur together, and Professor A. J. E. Lönnberg has told me that in the collections from east Greenland he has found plainly cylindric and decidedly palmate forms mixed among the horns of the now-existing east Greenland reindeer. It is therefore scarcely likely that definite results with regard to the various varieties of reindeer will be reached until skulls shall be forthcoming."

period in Norway. The district of Vaage is not situated on the west coast, yet I have but little doubt that the ancestors of the mammoth which came to grief there immigrated to western Norway from Scotland over the Scoto-Norwegian land bridge. I will emphasize here that *Elephas primigenius* has been found fossil not only in Scotland, *but also in Ireland,* thus adhering to the general distribution of most of the "Atlantic" species we are dealing with. It "is most abundantly found in all the British Pleistocene deposits from the Forest bed of Norfolk upwards. . . . It is one of the few Pleistocene species that have been found in Ireland. The animal must have lived in Britain in vast numbers, and for a long time."[1]

The Vaage district is directly on the line between Dovre, Lom, and Nordfjord. Nordfjord, on the west coast, is nearly in the center of the area which in Norway must have constituted the northeastern abutment of the Scoto-Norwegian land bridge. It is probably along the same route that the "Arctatlantic" plants penetrated into the adjacent interior plateau regions of Norway where they form such a conspicuous part of the flora.[2]

The occurrence of the mammoth in connection with this particular element of the flora is highly suggestive.

V. Two "Atlantic" Species of Birds

That various species of land birds occasionally visit west Norway from Scotland there is ample evidence, I need only mention *Motacilla boarula* and *M. raii*. That others migrate regularly back and forth between the two countries is also fairly well established. The former, as a rule, do not seem to establish colonies,[3] and with regard to the latter we have only the theory to go by that they migrate along their ancient line of dispersal. Such a theory, if unsupported by evidence of a former land connection, would be worthless, but

[1] W. Boyd Dawkins, Brit. Pleistoc. Mamm., 1866, Introd., p. xxxiii.

[2] See Wille, Invandr. Arct. Flora Elem. Norge, in *Nyt. Mag. Naturv.*, XLIII, 1905, p. 337.

[3] Mention should be made of the fact that the black-backed English wagtail (*Motacilla alba lugubris*) breeds, at least occasionally, in western Norway near Stavanger and Bergen according to Collett (*Nyt Mag. Naturv.*, XXXV, 1893, p. 104), a reference which seems to have been overlooked by Hartert in his Vögel der Paläarktischen Fauna. No weight is attached to this invasion which seems to be quite recent, a surmise which is strengthened by the facts that the bird is only an occasional visitor to the Shetlands, that the typical *M. alba* is the breeding bird of Ireland, and that it also breeds here and there in England and Scotland.

in this case the two theories mutually support each other and thus, to some extent, possess the merit of corroborative evidence.

There are two birds, however, the geographical distribution of which is so interesting and bears so directly upon the attempt made in this essay to demonstrate the existence of a well-assorted and peculiar biota having made its way from Scotland to west Norway since the climax of the glacial epoch, that their case deserves a closer scrutiny in this connection, especially as their geographical distribution has never been viewed from this standpoint before. It is somewhat parallel to that of the ptarmigan (*Lagopus mutus*), but as I have already referred to that species before in a similar connection (*Amer. Natural.*, XXXV, 1901, p. 106) and am going to allude to it again in a subsequent chapter of this paper (p. 488) I shall not mention it further here.

The first of the two birds is the twite, or "mountain linnet" (*Cannabina flavirostris*). As a breeding bird it is absolutely confined to Ireland, northern Great Britain and western Norway. Professor Newton (Yarrell's Hist. Brit. Birds, 4 ed., II, 1876, p. 161) in speaking of the distribution of this bird in England says that "it breeds in some abundance in the more hilly districts of the Midland Counties—Hereford, Salop, Stafford, Derby and Chester, as well as in North Wales and the Isle of Man, and on elevated moorlands in the higher glens with increasing frequency northward from Lancashire and the West Riding of Yorkshire to Shetland, though in some districts it is rather scarce, and its stronghold in the west of Scotland is the Outer Hebrides. In Ireland it is found from north to south, and probably breeds in suitable localities throughout the island." In Norway it breeds rather commonly along the west coast from Jæderen northward to Lyngen (70° north latitude). Collett "found it most numerous on the islands of Bergen Stift, and on the Trondhjemsfjord and on Hitteren." Small colonies have also been found in the Alpine belt of the western mountains (Collett, *Nyt Mag. Naturv.*, XXXV, 1893, p. 83).

The twite is not a regular migratory bird, but belongs to the category of winter birds which Seebohm aptly calls "gipsy migrants." It does not winter only in England, but in Norway as well, occasionally even as far north as Trondhjem, though many extend their irregular wanderings to the continent.

Cannabina flavirostris although now more or less confined to the islands and coasts of the north Atlantic is not originally a maritime bird, and it is very extraordinary indeed that we do not find it, or a representative of it, in the mountain districts of central and

southern Europe. It is hardly necessary to remark that we have no fossil evidence of its former occurrence there, yet it can scarcely be doubted that at one time its line of dispersal from the east lay in that direction and that, like the lemming and many other species of the same invasion, it became extinct in the Alpine regions of the south. The evidence of such a connection with Asia is furnished by the slightly different form, *Cannabina brevirostris,* which is so closely allied to it that Hartert has connected the two forms trinominally in spite of the hiatus of 2,000 statute miles (3,220 km.) between their breeding areas. This Asiatic form of the twite extends from Caucasus through Persia, Turkestan and Tibet into Manchuria, and it is inconceivable that the two forms have not been separated in comparatively recent times.[1]

The second species is the rock pipit, *Anthus petrosus,*[2] which doubtless is only a subspecies of a circumpolar species and for that reason will be known by many ornithologists as *Anthus spinoletta petrosus.* The group of forms embraced by them in the term *A. spinoletta* is represented in subarctic North America (I speak only of the breeding ranges) by *A. pensilvanicus,* in eastern Asia by *A. japonicus,* in central Asia, west to the Caucasus by *A. blakistoni,* while a special form *A. coutellii* is peculiar to the mountain regions of Persia. "*A. spinoletta spinoletta*" to them is the name of the bird which "during the breeding season inhabits the mountains of central and south Europe, the Vosges, the entire region of the Alps up to an altitude of 2,500 m., the Schwarzwald, the Hartz Mountains, the Sudeten, the Thuringian Forest, the Pyrenees, the high mountain systems of Spain, the Karpathians, and the mountains of the Balcan Peninsula and Asia Minor, as well as the high mountains of Italy and surely also Sardinia" (Hartert, Vög. Paläarkt. Fauna, III, 1905, p. 280). In all these localities the water pipit, or Alpine pipit, as Seebohm has proposed to call this type, is confined to the moun-

[1] Another closely allied form from Kashmere has been described recently by Hartert. It will stand as *Cannabina flavirostris stoliczkæ,* or *C. brevirostris stoliczkæ* according to the view as to the degree of distinctness of *C. brevirostris.*

[2] This is the bird usually known to European ornithologists as *Anthus obscurus.* The name *Alauda obscura* given to it by Latham, in 1790, is antedated by the two years older *Alauda obscura* of Gmelin (Syst. Nat., I, ii, 1788, p. 801) which is an entirely different bird. Montagu's *Alauda petrosa* (*Trans. Linn. Soc. London,* IV, 1798, p. 41), based on the same specimen which served Latham as type of his *A. obscura,* must, therefore, be adopted as the oldest available name.

tains. As we approach the north and west we meet forms which breed at the level of the sea. Thus a race rather lightly spotted with black and suffused with rust color on the breast in the breeding plumage, *Anthus littoralis,* extends from Denmark along the west coast of southern Sweden to Hvaler, a group of islands at the southeastern corner of Norway. On the other hand, a heavy-spotted form, without a distinct wash of rufous on the breast, *A. petrosus,* makes its appearance as a breeding bird on the coasts of northern France, extending northwards through Great Britain and Ireland to the Scottish islands and to western Norway north to Finmarken. An extreme race of this form occurring in the Færœs has recently been distinguished as *A. spinoletta kleinschmidti* (Hartert, Vög. Paläarkt. Fauna, III, 1905, p. 284).

The rock pipit, as stated, breeds along the coasts of the British islands. Saunders (Illustr. Man. Brit. Birds, 1889, p. 135) says that "in Scotland it is abundant in suitable localities, especially in the west, and it is equally common in Ireland." Dresser quotes Robert Gray to the effect that it is common "on all the northern islands, including the outer Hebrides, Monach Isles, Haskar Rocks and St. Kilda," and continues: "Mr. Dunn found it very abundant in all parts of Shetland, and Captain Clark-Kennedy informs me that he has met with it very abundantly along the shores of Caithness, Sutherland and others of the northern counties of Scotland, and especially numerous in the Orkneys" (Birds of Europe, III, p. 344).

In Norway it breeds commonly on all the islands and along the entire outer coast up to Varangerfjord in East Finmark, but it never breeds in the interior of the country.

With the Baltic rock pipit (*Anthus littoralis*) breeding in the extreme southeastern corner of the country we have in Norway, consequently, two forms of rock pipit,[1] although some authors seem to think that the typical *A. petrosus* does not occur there and that the

[1] To Professor Robert Collett belongs the honor of having discovered and repeatedly called attention to this fact (*Nyt Mag. Naturv.*, XXIII, 1877, p. 144; XXVI, 1881, pp. 306–307), naming the west coast form typical *A. obscurus* [= *petrosus*] and the "variety occurring in the southern part of Sweden," with "light rusty yellow and more unspotted lower surface," *A. rupestris.* Nilsson, however, gave the latter name only as a substitute for *A. obscurus* considering, as he did, the latter ineligible because there are several species of *Anthus* to which the name *obscurus* applies. Brehm's *Anthus littoralis* (*Lehrb. Naturg. Europ. Vög.*, I, 1823, p. 239) is based upon specimens collected on the island of Oehe, on the east coast of Schleswig, and is apparently the south Swedish and Danish bird.

bird inhabiting "the coasts of Scandinavia" is the *A. spinoletta littoralis* (Hartert, Vög. Paläarkt. Fauna, III, 1905, p. 284).

The distribution of these forms in Norway plainly indicates the way by which they entered the country, *A. petrosus* from the west, *A. littoralis* from the south.

The rock pipit in western Norway is a "gipsy migrant" like the twite, many individuals wintering along the coast at least as far north as the Trondhjemsfjord (Collett, *Nyt Mag. Naturv.*, XXVI, 1881, p. 307), while others undertake more or less extended wanderings in various directions.

VI. The "Atlantic" and "Arctatlantic" Plants in Western Norway

The late Professor Axel Blytt, in his celebrated paper on the immigration of the Flora of Norway (*Nyt Mag. Naturv.*, XXI, 1876, pp. 279–362) clearly distinguished two elements among others, in the flora peculiar to western Norway, viz., those plants which extend from Stavanger northwards and which are chiefly characteristic of the coast between the latter city and Kristianssund, and those which do not occur north of Stavanger. The former he named (p. 339) the *Atlantic*, or Bergen coast plants, the latter the *Subatlantic*, or Kristianssand coast plants. These he believed to have come to western Norway "over the sea from the southwest," though the context shows that he meant from Denmark. Among these *Ilex aquifolium*, the holly, is one of the most conspicuous plants and occurring, as it does, from Arendal to Kristianssund, consequently covering the range of both the Atlantic and the Subatlantic plants, the combined assemblage is often called the *Ilex*-flora. This nomenclature is very unfortunate since, as I hope to show, the two categories probably have arrived in Norway from two different directions, the former from Scotland, and the latter from Denmark.

As already stated, the Atlantic plants in western Norway have their main distribution between Stavanger and Kristianssund, or roughly between 59° and 63° north latitude, and are mainly confined to the coast without even penetrating into the deeper western fjords, but many species have extended their range considerably further north and south so that a few of them have even reached the western coast of Sweden. About 60 species of vascular plants are regarded as belonging to this category.

The Subatlantic flora is probably equally rich in species and oc-

cupies the southern coast from Stavanger east to the Swedish frontier, the center of distribution being between Mandal and Arendal.

The essential difference between these two groups of plants is not one of lesser or greater hardiness and consequent latitudinal difference in south-and-north extension. It is rather one of general distribution, the Subatlantic species being of more eastern affinities and range than the Atlantic ones, indicating a previous history of evolution and dispersal entirely different in the two groups. This is not only shown in their having two distinct centers of distribution in Norway, but also by their respective ranges in Denmark and especially in Ireland. All the true Atlantic species in western Norway are also found in northern Scotland and almost all in northern and northwestern Ireland. The Subatlantic species, on the other hand, as a rule, do not reach Scotland and some even miss southern Ireland.

Blytt's conclusions were based chiefly on the distribution of the vascular plants. Since his time the bryophytes of Norway have been studied more in detail, and the results yielded by them for our purpose are even more conclusive, especially the recent studies of the Norwegian hepaticæ (liverworts) by Kaalaas (*Nyt Mag. Naturv.*, XXXII, 1892–1893, pp. 1–490) and by Jörgensen (*Bergens Mus. Aarb.*, 1901, No. 9 and No. 11). According to them there are no less than 27 species of "Atlantic" hepaticæ on the west coast of Norway, as follows:

Lejeunea calcarea.
Lejeunea ulicina.
Lejeunea ovata.
Lejeunea patens.
Radula aquilegia.
Radula carringtonii.
Porella radicata.
Porella platyphylloidea.
Pleurozia cochleariformis.
Pleurozia purpurea.
Lepidozia pearsoni.
Lepidozia pinnata.
Adelanthus decipiens.
Kantia arguta.
Saccogyna viticulosa.
Herberta adunca.
Scapania gracilis.
Scapania planifolia.
Scapania ornithopodioides.
Plagiochila punctata.
Jungermannia orcadensis.
Jungermannia atlantica.[1]
Jungermannia ovata.
Jungermannia doniana.
Nardia compressa.
Gymnomitrium crenulatum.
Fossombronia angulosa.

[1] This has not been recorded from Britain, as yet, but since it has been credited to the Færöes by Jensen (Bot. Færöes, I, 1901, p. 133) it will probably eventually be found in Scotland also, if really an Atlantic species.

All of these, except *J. atlantica,* have been found in Great Britain and Ireland and no less than seven, or 25 per cent., are thus far known only from western Norway, Scotland and Ireland (two also from the Færöes and one as yet only from the latter and Norway). Several of the others extend only to western France.

Blytt also distinguished in the Norwegian flora another element which he termed specifically the "Arctic" plants, generally supposed to have entered the Scandinavian peninsula gradually from the south, immediately following up the melting of the great ice cap. In a recent paper, however, Professor N. Wille[1] has shown most conclusively that this theory is not borne out by the facts and that the "Arctic" flora, so far from being of homogeneous origin, consists of at least two very distinct elements, one which is of decided Siberian relationship and which entered northern Norway from the east *via* the Kola peninsula, and another which he believes to have come from Greenland *via* an Iceland-British-Norwegian land bridge and to have survived the last glaciation on an ice-free coast along western and northern Norway. He consequently reaches a conclusion agreeing in many points with that of Dr. Hansen (see *antea,* p. 461). He sums up his results as follows (p. 337): "The facts at hand, therefore, seem to me to indicate that during the last ice-period there lived in Norway a high-arctic vegetation on an ice-free coast which must have extended as far south as the Sognefjord [61°]. Later on several species of high-arctic plants, which in the course of time immigrated into northern Scandinavia from Russia and Siberia, have pushed southward to a lesser or greater extent. As the land ice retreated from the south and east after the conclusion of the last glacial epoch a subarctic rather than an arctic vegetation followed from Sweden into southeastern Norway."

The element of the west Norwegian flora, which it may be convenient to designate as the "Arctatlantic" element, must consequently have come from the west, from Scotland, and it is highly significant to note that Wille, whose studies of the fresh-water algæ of the Færöes have been quoted in defense of their reaching these islands across the sea[2] now admits the probability of a land bridge (p. 318) and the insufficiency of explaining the presence of the Arctatlantic element *as a whole* upon the theory of accidental dis-

[1] Om Indvandringen af det Arktiske Floraelement til Norge, in *Nyt Mag. Naturv.*, XLIII, 1905, pp. 315–338.

[2] See *postea,* p. 490.

persal (p. 319). It is also to be noted that he specifically excludes Jæderen (p. 337) and the coast south of it from the *direct* line of invasion and shows that the Arctatlantic plants reached that part of southwestern Norway at a much later period.

VII. The Way of Dispersal into Western Norway

It is clear that if a more or less ice-free land bridge existed between northern Scotland and west Norway during the glacial period, a whole complex biota must have crossed it. Animals and plants are so closely bound together that the movement of the fauna must necessarily depend upon that of the corresponding flora. Whether such an invading biota is to be composed of many or few species is determined by several circumstances. Of these the length of time during which the land connection lasted, the diversity of environment, including climatic conditions, and the distance in space from the center whence the biota emigrated, are the principal factors. A consideration of the simple fact that some species spread much slower than others shows this contention to be true. Therefore, if we remember that part of the association of plants and animals, which in this paper it is suggested immigrated into western Norway by a Scoto-Norwegian land bridge, at one time must have had its center of distribution in western continental Europe before entering England, while a large portion of the animals are supposed to hail even from western Asia, it will be seen that a considerable distance had to be traversed and that western Norway lies at the extreme end of a long and tortuous route. Small wonder if the fauna and flora are found to be somewhat attenuated when reaching their farthest point. Many species in this westward and subsequent northward and finally eastward push must have lagged behind, and in corroboration of this theory we should expect to find conspicuous forms which were unable to keep up with the procession and thus failed to reach western Norway before the final submergence of the land connection. As a matter of fact, there are many such species, but it is not necessary to refer here to others than the muskox (*Ovibos moschatus*) and the banded lemming (*Dicrostonyx torquatus*) which are not found in Norway, living or fossil.

On the other hand, it must be emphasized that the species and forms referred to above are not the only ones which came that way, but they are only those of which we know that they differ structurally from the other individuals which may have invaded the peninsula from other directions. Many plants and animals of gen-

eral distribution and of uniform morphological characters throughout their range probably accompanied the more easily differentiated members of the various invasions and meeting again in Scandinavia resumed their former continuity. Thus the pine (*Pinus sylvestris*) may have come to Scandinavia by two different routes, from the south and from Scotland.[1] As far as I know, a thorough comparative study of the morphological characters of the Scotch and west Norway pines has not been made to ascertain if any (possibly quite minute) differences exist which distinguish them from the east Scandinavian pine, although from experiments made in western Norway with seeds from the Scotch tree there seems to be at least some physiological similarities between them as distinguished from the eastern pines.

Slight morphological differences between Scotch and Norwegian forms, however, need not mean that they have no genetic relation. It depends upon other circumstances how such differences may be interpreted. While undoubtedly many species may have retained their identity in spite of the segregation on both sides of the North Sea since glacial times, others more plastic, as the phrase is, may have been differentiated into diagnosable races on account of a similar geographical separation during the same space of time. Take as an example the case of the tundra ptarmigans (*Lagopus mutus* and *L. rupestris*) which ornithologists consider different species. The former extends in Scandinavia east to the White Sea, the latter from there on eastwards, while in the west and south *Lagopus mutus* still lives in Scotland, the Alps and the Pyrenees. At least two of these isolated colonies of the ptarmigan have become slightly differentiated, viz., the Scandinavian and the form inhabiting the Alps. Whether the Scotch and Pyrenean ptarmigans also show the effect of the long segregation is not known but matters very little in the present connection, since the general distribution of the collective species is fair proof of its belonging to the whole assemblage of animals and plants which came to Norway from the west.

However, granting that such a biota invaded Norway from the direction of Scotland, does it necessarily follow that it traveled over a continuous land bridge?

In attempting to answer this question it is imperative to discuss the various categories composing the flora and fauna involved.

[1] Analogous to the dual origin of the spruce (*Picea*) in eastern and northern Norway.

Beginning with the plants, we have two extreme parties among the phytogeographers, those who insist upon the slow and gradual dispersal of the flora over land connections, and those who, like Warming and Sernander, see no difficulty in assuming that entire plant associations by the aid of wind, ocean currents, migrating birds, etc., are enabled to cross extensive bodies of salt water, such as the Skagerak, the North Sea, or even greater stretches of open ocean. These diametrically opposed views have led to a very instructive discussion about the dispersal of the flora of the Færöes, which it will be profitable to review here in some detail, because of the direct bearing it has upon our own studies.

In the "Botany of the Færöes based upon Danish Investigations," pt. I, pp. 112–119 (Copenhagen and London, 1901), C. H. Ostenfeld has a chapter on "The Immigration of the Flora," in which he states as his belief derived from a study of the phanerogams and pteridophytes and a full discussion of the various theories, that apart from a few species "introduced by the agency of the winds (and birds?)," "the chief part of the present flora of the Færöes has migrated across a postglacial belt of land" (p. 118) from Scotland, with the flora of which it "bears a wonderful resemblance." He thinks that "if it had been a question of immigration across the sea, the flora taken as a whole would hardly have been so very much like that of Scotland. It would have consisted of fewer species" (p. 115). The above conclusions were based upon the vascular plants, with the exception of the difficult group of the *Hieracia* which were studied by H. Dahlstedt. From the latter's account (Bot. Færöes, pt. II, 1903, pp. 625–659) I quote the following:

"Usually the different forms have not a wide geographical distribution. I am therefore of opinion that the study of the *Hieracia* of a single district in its relation to the neighbouring floral districts ought to be particularly useful as a contribution towards the solving of various plant-geographical questions. This has become still more clear to me by studying the *Hieracium*-flora of Scandinavia. I think that it will more particularly be of great help to us in determining the ways by which a flora of a land immigrates, and also the relative time for its immigration. The composition of the *Hieracium*-flora of the Færöes confirms the opinion expressed by C. H. Ostenfeld regarding the origin of the rest of the phanerogamous flora" (p. 626).

"It is an interesting fact that the Atlantic element in this genus

is so strongly represented in the Færöes. The presence of this element lends considerable weight to the theory of a postglacial land connection, which perhaps existed much longer than we have hitherto believed, judging from the other data" (p. 628).

Several years before the above conclusions of Ostenfeld and Dahlstedt were published Professor N. Wille, in a paper on the fresh-water algæ of the Færöes and on the modes of dispersal of these algæ in general (Botaniska Notiser, 1897) argued for their dispersal over the open sea chiefly by the aid of wind and, especially, migratory birds. F. Börgesen who worked up the fresh-water algæ for the Botany of the Færöes (pt. I, 1901, p. 202) quite agrees "with Wille in thinking that the flights of birds which yearly take up their abode in the Færöes, or pass the islands on their way northwards *could*[1] very easily have conveyed to the islands the fresh-water algæ-flora—and *perhaps*[1] the whole of the flora—which is found there" (p. 202). In this conclusion he is fully sustained by Professor Eug. Warming who in the final chapter, "the History of the Flora of the Færöes" (Bot. Færöes, II, 1903, pp. 660–681) says: "I regard a postglacial land connection *very improbable,* and *not necessary* for the immigration of the Flora, which may be assumed to have immigrated across the sea" (p. 664). He admits, however, that "it is somewhat difficult to find evidence *against* the existence of a land connection, but it appears that one may be obtained from the *fauna of the Færöes.* It contained originally no wild terrestrial mammals, neither foxes, hares, moles, nor mice" (p. 670). He also finds unquestionable evidence in the flora, viz., the presence of the many temperate European or Atlantic species on account of the severe climatic conditions necessarily resulting from a land connection, although he apparently considers this objection valid only "were the bridge to be continued uninterruptedly to Greenland" (p. 671).

The belief in a postglacial land connection between the Færöes and Scotland has been particularly strong in the latter country and apparently, Warming's arguments have not had any great effect there (see the review of his article in the *Scottish Geographical Magazine,* XX, February, 1904, p. 98).

The net result of this discussion to us is a confirmation of our previous conviction that plants, as a rule, do not furnish an infallible

[1] Italicized here.

[2] It is well to recall that Professor Wille has since apparently changed his opinion about the land bridge (see *antea,* p. 486).

proof of an uninterrupted land bridge. It has been shown that some plants travel considerable distances across the ocean and become established, "remember Jan Mayen"! to use Warming's expressive and effective slogan. Jan Mayen island is located 240 miles (450 kilometers) from Greenland, the nearest land, exactly the distance between Scotland and western Norway, and it is about as certain as such an assertion can be, that its 39 vascular plants have come across the sea. Such a flora, however, in its composition shows its accidental character. On the other hand, the example of "Gottska Sandœ," in the Baltic, a small island situated less than 20 miles (37 kilometers) from the large island of Gotland and 50 miles (93 km.) from the mainland of Sweden, a moraine bank emerged from the sea during the *Littorina* epoch of postglacial times, shows that complete plant associations may be transported over the sea. Sernander (Skandinaviska Vegetationens Spridningsbiologi, Upsala, 1901, p. 407) remarks expressly that "in none of its plant associations are any gaps noticeable in comparison with the corresponding associations on the mainland," but the distances here involved are slight, of course, compared with those between the Færöes and Scotland or between the latter and Norway. With regard to the Færöes it is difficult to believe that so complete a representation of the Scotch flora could have crossed a sea about 170 mile (315 km.) wide, the distance from Scotland at the present level of the sea. If we assume, however, that the Færöes were connected with Scotland during the maximum glaciation, and that this connection afterwards ceased through a gradual submergence, it is evident that the distance between land and land for a considerable time cannot have been much more than 60 miles (111 km.). The conditions under such circumstances must have been favorable enough to have allowed the immigration of the temperate Atlantic species to which such a distance would not be prohibitive. This suggestion would explain the whole of the Færöe situation, and I hope further on to show that it is the probable solution.

Applying the above to the question of the invasion of the west Norway biota we conclude that the so-called Atlantic and Arctatlantic flora there cannot have crossed the North Sea as it is now limited. On the other hand, I am not prepared to deny the *possibility* of the whole assembly having crossed the 40 miles (74 km.) of the Norwegian channel, though I confess that I have my doubts whether such plants as the 27 species of Atlantic hepaticæ could have been transported that distance over the sea. But the most important

conclusion is, that if the terrestrial fauna can be shown to have come that way, the plants fully sustain the whole theory of a land bridge. The plants in that case more particularly prove the direction whence came the invasion, while the animals demonstrate, in addition, that there must have been a land bridge in that direction.

Not all terrestrial animals,[1] however, are equally suitable to prove such connection. Obviously, birds are of less use than plants. Their general distribution, such as that of the ptarmigan, the twite, and the rock pipit, may show the direction whence they came, but even the ptarmigan would be able to cross the Norwegian channel, though it is very doubtful if it could cross the North Sea at the present level of the sea. I am, therefore, not going into detail here about cases such as those of the west Norway wren (*Anorthura bergensis*) and the chickadee (*Parus colletti*) although they fit very well into the general scheme. I have on another occasion (SMITHSON. MISC. COLL. (Quart.), XLVII, 1905, pp. 428–429) called attention to the case of the dipper (*Cinclus*), and shall here only mention *Columba livia*, the rock pigeon, as another bird which probably reached west Norway from Scotland.

The insects also will have to be left out of consideration, though it should be mentioned that an element of the west Norwegian insect

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[1] The present essay deals only with the terrestrial biota, but if a Scoto-Norwegian land bridge ever existed, as here suggested, a littoral fauna and flora must have accompanied the dispersal of the terrestrial one. To prove in detail the existence of such a littoral assemblage would add a very important link to the chain of evidence, but various reasons prevent its elaboration by me. The case of a characteristic littoral fish may serve as an example in this connection, however.

The *Blennius* (*Lipophrys*) *pholis*, or shanny, is one of the most characteristic beach animals. According to Day (Fish. Great Brit. Irel., I, 1884, p. 204) it "is found in rock pools accessible at low water and does not appear to frequent deeper localities." Smitt (Scand. Fishes, 2d ed., I, 1892, p. 216) says that it "prefers to live above low-water mark and seems . . . to find pleasure in being left dry at ebb-tide." The female deposits its eggs in "a small hole with a narrow entrance just above low-water mark." Its geographical distribution is characteristically "Atlantic." "Its true home is on the coasts of Great Britain and Ireland, extending southward . . . into the Mediterranean at least as far as Barcelona" (Smitt, p. 217). According to Day (p. 205) it "appears to be distributed almost everywhere in pools between tide marks around the British coast. . . . In Ireland it is common." It is not found in Denmark or Sweden, but in Norway it occurs on the west coast from Stavanger northward at least up to Manger, a little north of Bergen.

fauna corresponds exactly to the Atlantic group of plants, as shown by Sparre Schneider.[1]

The terrestrial isopods seem to possess means of rapid dispersal, and many of them probably owe their present wide range to the agency of man. An exception is apparently furnished by *Ligyda* (=*Ligia*) *oceanica* (Linnæus) which lives near the water's edge on exposed saltwater beaches. "Along the western coast of Norway this form" according to Sars (Acc. Crust. Norway, II, 1899, p. 157) "occurs rather plentifully and extends northwards at least to the Trondhjem Fjord," while outside of Norway it is found on the coasts of "Denmark, Prussia, Belgium, France, Spain, Britain, Færoe Islands." It is consequently an eminently "Atlantic" species, and there can be but little doubt that it has come to west Norway from Scotland. It can hardly be said to prove a land connection at any time, however, since it appears probable that it might be easily caried across salt water by currents for such a distance as the width of the Norwegian channel, though it is uncertain whether it could cross the North Sea at its present level.

The earthworms might furnish excellent tests for the presence of a land bridge, were their distribution known in greater detail and were we assured that they are not introduced recently by man. All the species thus far recorded from Norway[2] belong to the group which Michaelsen characterizes as "Weitwanderer," with the exception of an indigenous species, *Helodrilus* (*Bimastus*) *norvegicus*, which has been found in Suldal, Nordreisen, and Tromsœ. Michaelsen, however, regards it as a form of comparatively recent origin and doubtfully distinct specifically from *H.* (*B.*) *constrictus* which also occurs there. Of the thirteen species recorded by him from Norway nine occur about Kristiania and Drammen in the eastern part of the country, while four are reported from the western and northern coast only. Of these *Helodrilus* (*Allolobophora*) *longus* has only been found at Stavanger and may, therefore, be a recent

[1] Coleoptera og Lepidoptera ved Bergen og i nærmeste omegn (*Bergens Mus. Aarb.*, 1901, No. 1). On pp. 20–21 he enumerates 31 "Atlantic" coleoptera, 4 hemiptera, and 23 lepidoptera. On p. 9 he calls attention to the British bumblebee, *Bombus smittianus*, which also occurs along the extreme western coast of Norway from Jæderen to Lurœ in Nordland (66½° north lat.), and on p. 161 to the noctuid moth, *Aporophyla nigra*, which occurring at Bergen, but not in Denmark, Sweden, or Finland, furnishes among the lepidoptera "one of the most important proofs of the originally close connection between the British Islands and southwestern Norway."

[2] W. Michaelsen, Die Lumbriciden-Fauna Norwegens und ihre Beziehungen, in *Verh. Naturw. Ver. Hamburg* (3), IX, 1902, pp. 1–13.

introduction. The northern record of the three others, viz., *H.* (*Dendrobæna*) *rubidus* (*typicus*), *H.* (*B.*) *norvegicus* and *H.* (*B.*) *constrictus*, is very dubious, in as much as it uncertain which of them, if more than one, occurs on Lavangsfjell in Tromsœ Amt, and in Lofoten. However, as *H. rubidus* and *H. constrictus* belong to the most widely distributed species, their absence about Kristiania as well as in south and central Sweden, while occurring in Suldal, Stavanger and Bergen, in western Norway, is highly suggestive. The presence of one of these three in the province of Tromsœ and in the Lofoten Islands, and, last but not least, the fact that one of them has had time to differentiate into a separable form, make it pretty certain that we have not to do with species introduced by man. Add to this the occurrence of *H. constrictus* in Britain and *H. rubidus* in Iceland, and we have a distribution tallying very well with that of the other "Atlantic" species. Considered by itself the case of these earthworms cannot as yet be taken as conclusive evidence in favor of a Scoto-Norwegian land bridge, because of the many uncertainties involved, but in connection with the rest of the biota it assumes enough significance to justify our calling attention to it.

The land and fresh-water molluscs might also possibly furnish valuable data if their identity and distribution in west Norway were better known, especially as compared with the Scotch forms. Attention is here only directed to *Helix* (*Tachea*) *nemoralis* which according to Miss Esmark (*Journ. Conchol.*, v, October, 1886, p. 108) is "only found on the west coast" of Norway, from Bergen to Stavanger. The species, it is true, is common in Denmark and rather common in the extreme southern province of Sweden, but becomes rare northwards, only reaching Göteborg on the west coast of Sweden and Jemtland on the eastern side.[1] It will be seen, however, that the two habitats on the Scandinavian peninsula are widely separated. The distribution in the south and east shows the species to have arrived there from central Europe over the Baltic land bridge, while its characteristic "Atlantic" distribution in west Norway distinctly points to a land connection with the British Islands where it is widely distributed both in Scotland and Ireland.

Under other circumstances the most convincing tests for uninterrupted land connections are furnished by batrachians and fresh-water fishes. Unfortunately they are very slow travelers, especially the latter. The absence of evidence of any of them having crossed

[1] Westerlund, Synopsis Molluscorum Extramarinorum Scandinaviæ, in *Acta Soc. Fauna Flora Fennica*, XIII, No. 7, 1897, pp. 56–57.

the supposed Scoto-Norwegian land bridge is, therefore, no proof against its former existence, but may only show that the land connections we are considering in this paper only lasted a comparatively short time.[1] Most convincing evidence of this is furnished by the fact that while the characteristically "Atlantic" species are found both in Ireland and west Norway, though more numerous in the former than in the latter, neither has more than two species of tailless batrachians, viz., one frog and one toad, the frog belonging to the same species, *Rana temporaria,* the toad, however, to two distinct species, *Bufo bufo,* in west Norway, and *Bufo calamita* in southwest Ireland. Scotland and west Norway have also only two species in common, viz., *Rana temporaria* and *Bufo bufo,* and these might, therefore, have been suspected of having come to the latter country from the west, were it not that they are absent in the islands north of Scotland. The absence of *Bufo bufo* in Ireland is also against such an assumption, since it is probable that the connection between Ireland and Scotland was severed *after* the supposed connection between Scotland and west Norway had been broken. Both species, moreover, are widely distributed over the whole northern portion of the palearctic region from the Pacific to the Atlantic without any special western tendencies. Both probably entered Scandinavia from the south. West Norway is particularly poor in fresh-water fishes, the only land-locked species being the charr (*Salvelinus alpinus*), but as it frequents salt water in subarctic climates it is useless for our purpose.

These groups of animals failing us, we have to fall back upon the mammals as furnishing the second best test of a continuous land connection. Of course, if the terrestrial species which we have discussed above (pp. 462–480) came to west Norway from the west, there must have been at least a very close approximation of the two land areas. The red deer is a good swimmer and is able to cross

[1] That such a period, although "comparatively short," may represent a quite respectable space of time will be seen from the following consideration: Brögger (Strandl. Beligg. Sydœst. Norge, 1905, p. 290), estimates the time which in southeastern Norway has lapsed since the maximum of the postglacial submergence at 18,600 years. It is pretty certain that all the fresh-water fishes of eastern and southern Norway have immigrated since then into those parts of the country from southern Sweden. The climatic conditions may not at first have been favorable, but during the last 10,000 to 14,000 years they probably offered no obstacles. Nevertheless, not one of them has as yet reached the waters of west Norway. The much longer Scoto-Norwegian land bridge may, therefore, easily have lasted at least 10,000 years without any fresh-water fishes having been able to cross it.

fjords and sounds several miles wide, but it is not credible that it could have crossed the 40 miles of the Norwegian channel, if the latter had been formed and was always free of ice during the period in question. I have shown elsewhere, however, that this channel, if existing at the time, probably was frozen over in winter. But the smaller mammals cannot well be assumed to have wandered such a distance across the ice, and we are therefore compelled to conclude that the land connection was complete and uninterrupted at the time of this invasion.

We have thus come to the result that a composite biota, consisting of numerous cryptogamous and phanerogamous plants with a full complement of terrestrial animals during some period of glacial times subsequent to the megaglacial climax invaded western Norway between 59° and 63° north latitude from Scotland over a continuous land bridge which did not stay uninterrupted long enough to allow the slow traveling species, among them the batrachians and fresh-water fishes, to pass over.

VIII. The "Subatlantic" Biota

Before concluding the biogeographical considerations involved it is desirable to refer briefly to the plants and animals more or less characteristic of the southern coast of Norway between Stavanger and Arendal, which following Blytt's example have been termed the *Subatlantic* biota. At the western extremity of their distribution in Norway they meet the southern members of the Atlantic biota, their boundaries frequently overlapping. With a few of the more widely distributed species it is therefore sometimes difficult to decide to which of the two groups they properly belong. One of these is the holly (*Ilex aquifolium*), for which reason I have entirely discarded the term "Ilex-flora" as being ambiguous and confusing.

A characteristic feature of the distribution of these Subatlantic plants is that they occur in Denmark, separated from Norway by the 60 miles (111 km.) wide arm of the North Sea known as Skagerak. In Britain and in Ireland some are wanting and the distribution of others is decidedly southern.

We have seen above that Blytt and others regarded them as having invaded southern Norway from the south (p. 460) while other botanists maintain that they slowly crept along the west coast of Sweden into Norway. Many distributional facts, especially the lack of many of the species, living or fossil, in the intervening country, militate against the latter theory, and after Sernander has

shown that a channel as wide as the Skagerak is capable of being crossed by a numerous flora there is no necessity for assuming the more roundabout route.

On the other hand, there is no evidence to show that a terrestrial fauna has invaded Norway from that direction. It is pretty nearly conclusive evidence that none of the mammals assigned to the Scoto-Norwegian invasion have been found fossil in Denmark. True, both reindeer and red deer have been found there, but an inspection of Winge's photographs (*Vid. Med. Naturh. For. Kjöbenhavn*, 1904, pls. VII, XI) of specimens in the Copenhagen Zoological Museum shows that they belong to forms different from those inhabiting Norway. Of the red deer Winge (p. 262) indicates two different types in Denmark, one confined to the islands, the other occurring alone in the Jutland peninsula, but also occasionally in the islands. A comparison of Lönnberg's fig. 1 (*Ark. Zool.*, III, 1906, p. 4) with Winge's pl. VII, fig. 2, suggests the identity of the Danish fossil island form with the red deer of south Sweden, the typical *Cervus elaphus*, while the Jutland form may well be the same as one of the continental European races which Lönnberg terms *Cervus elaphus germanicus* (Desmarest). So much appears certain, however, that none of the Danish red deer have anything to do with the Scoto-Norwegian *Cervus atlanticus*.

It seems then fairly well established that while southern Norway has received part of its flora and fauna from the south during post-glacial times, as distinguished from the biota which entered from the southeast, there was no direct land connection between Denmark and Norway during that period.

IX. A Sketch of the Geological Considerations Involved

I have now arrived at the point hinted at in the introduction to this paper (p. 459) where it becomes incumbent upon me "to show that my theories are not inconsistent with accepted principles and with the general outline of conservative geological opinion," and I hope to be able to do so in the following pages.

That a Scoto-Norwegian land bridge is not the mere fantastic vaporings of a biogeographer with a theory to prove, can be shown by numerous quotations from the writings of prominent geologists and physiographers. Thus professor J. W. Judd, in his presidential address to the Section of Geology of the British Association (Rep. Brit. Ass. Adv. Sci. Aberdeen Meet., 1885, p. 1001) has the following to say:

"The early history of Scotland is inextricably interwoven with that of Scandinavia. . . . To us the separation of Scotland and Scandinavia is an event of very recent date indeed; it is not only an accident, but an uncompleted accident! The Scottish Highlands, with the Hebrides and Donegal on the one hand, with Orkney and Shetland on the other, must be regarded—to use a technical phrase—as mere 'outliers' of the Scandinavian peninsula."

Dr. Hans Reusch, the distinguished director of the Geological Survey of Norway, in 1888 (Bömmelöen og Karmöen, p. 420), concludes that "the Scandinavian mountains assuredly constitute with the mountains in the northern part of the British Islands *a single system* only interrupted by the subsidence of the area of the German Ocean," or North Sea. Suess (Antl. Erde, II, 1888, p. 100; Face Terre, II, 1900, p. 125) endorses these views and states that Shetland, the Orkneys, the Scotch Highlands, a large portion of Ireland and Wales "are to be regarded as the continuation of the folded mountains in Norway. The sea which separates Scotland from Norway, as shown by the enormous faults of the Scotch coast, lies over a sunken portion of this mountain system . . . the *Caledonian Mountains*."

The hydrographers have come to similar results. The latest, most thorough, and most detailed study of the problem is by Professor Fridtjof Nansen (Norweg. North Pol. Exped., IV, No. 3, 1904), who in reviewing the history of the formation of the Norwegian continental shelf concludes (p. 166) that it "has comparatively recently been elevated, at least 300 m. ['or probably more' p. 189] higher than now, when the level of the barriers of the great submarine fjords was developed." As to the time he adds on p. 167: "To judge from the similarity between the continental shelves of Norway, the Færöes and Iceland, it seems probable that the shelf is, at least to a great extent, postmiocene, *i. e.*, pliocene and pleistocene."

This suggestion as to the time of the land bridge is fully borne out by the investigations of Peach and Horne regarding the glacial phenomena of Shetland and Orkney, which point to "the conclusion that they were glaciated by land ice that moved from the North Sea towards the Atlantic" and "that the ice must have moved westwards across the submerged platform of which Shetland and Orkney are the surviving relics" (Rep. Brit. Ass. Adv. Sci. Aberdeen Meet., 1885, pp. 1036–1077). Professor Judd, in the presidential address alluded to above is even more definite as to the time, as follows (p. 1008):

"Down to postglacial times Scotland, and what are now its outlying islands remained united with Scandinavia. I need not remind you how, during the glacial period, they were the scene of a similar succession of events; while from their then far more elevated mountain-summits streams of glacier-ice flowed down and relieved the mantle of snow which enveloped them.

"But at a very recent geological period, and indeed since the appearance of man in this part of our globe, the separation of the two areas, so long united, was brought about. In the district now constituting the North Sea, which separates the two countries, great faults, originating in the Tertiary epoch, appear to have let down wide tracts of the softer secondary strata among the harder crystalline rock-masses. The numerous changes of level, of which we find such abundant evidence around the shores of this sea, facilitated the wearing away of the whole of the softer secondary deposits, except the slight fringes that remain along the shores of Sutherland, Ross and Cromarty, on the one hand, and the isolated patches forming Scania, Jutland, and the surrounding islands on the other. Little could the Vikings, as they sailed over this shallow sea, have imagined that their predecessors in these regions were able to roam on foot from Norroway to Suderey!"

These quotations might be added to *ad libitum* and, as hinted at in my introductory remarks, I might make my task easy by simply showing that eminent geologists have advocated the existence of a Scoto-Norwegian land bridge in postglacial times, that is, *after* the disappearance of the neoglacial ice sheet. If it were generally accepted, if it could be termed "an established geological fact" that the distribution of land and water in northern Europe "*after* the epoch of the last great Baltic glacier" was as represented in Geikie's map (Great Ice Age, 3 ed., 1894, pl. XII) there would probably be very little opposition to my theory of the Scotch origin of the characteristic biota of west Norway. Unfortunately, a postglacial connection meets with disapproval of geologists equally distinguished. It is the latter which I must try to convince that the animals and plants discussed here may have come from the west, or at least I must try to make my case so plausible that they are willing to consider the question in the light of the facts and theories brought together in this paper.

In glancing over the Norwegian geological literature relating to these questions one is struck by the great attention given to the various glacial submersions and the corresponding deficiency with

regard to the elevation of the land during the same periods. The reason is obvious, viz., that on the present surface we have evidence of the former subsidence, while the sea hides the land which once connected islands and continents. Positive proof of these connections, and of their extent in time and space, are therefore much more difficult to produce. The impression left upon the casual student of these phenomena is therefore unavoidably that the glacial epoch was one of subsidence chiefly, consequently it cannot be too strongly emphasized, that while this is true to a great extent with regard to the later phases of the glacial time, it is not true of the early and middle stages.

That there is ample proof of western Norway having had an altitude of *at least* 180 meters higher than now since the megaglacial stage is conclusively shown by no less authority than Professor W. C. Brögger.[1] The accumulations of littoral species of shells on the banks off the west coast of Norway at depths down to 180 meters or more demonstrate a corresponding elevation which, according to him, existed immediately before and possibly during the early stages of the second (Scandinavian) glaciation. He synchronizes this elevation with the one demonstrated by Judd and others from the Rockall bank, and by Jensen from the Færöes, both of which indicate elevations of at least 180 meters: "The entire material of observations anent these sunken littoral banks, with a fauna partly to a greater extent arctic, partly mixed, and partly southern, thus points to an extensive elevation of the sea bottom from Iceland, the Færöes, Rockall, Scotland, the Shetland Islands to the Norwegian coast during the last interglacial period" (p. 107). It should be noted, however, that both the reports of the Rockall expedition and of A. S. Jensen refer this elevation to the postglacial period, that is, to the time *following* the neoglaciation (second Scandinavian glaciation). This question, therefore, appears to the biographer as being still open, and it is so regarded in the following considerations.

The most superficial study of the phenomena of the glacial epoch demonstrates that there were great changes of level, and more elaborate research establishes the fact that these changes not only vary locally in intensity, but that the rise and fall of the sea-level is not synchronous over the whole area affected. I need only mention what Knipowitsch says on the last page of his monumental "Grundzüge der Hydrologie des Europäischen Eismeeres (*Zap.*

[1] Om de Senglaciale og Postglaciale Nivaaforandringer i Kristianiafeltet, in Norges Geol. Undersög., No. 31, 1900, pp. 100–111.

Imp. Russk. Geog. Obstch., XLII, 1906, p. 1510): "The depressions and elevations need not at all take place uniformly over large areas. These processes may occur in entirely different ways in the various parts of the same ocean. While one part of the ocean shows great depression or elevation of its floor, another may be affected much less, or not at all, or may even show opposite processes. The unevenness and irregularity of the depressions and elevations may cause a very complicated sequence of the physico-geographical as well as biological changes."

Such diversity does not point to cosmic causes. As a matter of fact, the changes of level are so intimately connected with the various phases of the glacial phenomena that it seems out of the question to regard them as mere coincidences.[1]

Of the various theories which have been propounded to account for the uneven submergence and elevation of the land masses, the one which attributes the depression to the weight of the accumulated ice and the elevation to the unloading of the enormous weight by melting under different climatic conditions, seems to meet most of the requirements which can be put to it. This hypothesis is based upon the theory of the elasticity of the earth's crust, the necessary consequence of which is, that if the crust be depressed in some places, it must rise correspondingly elsewhere, while between these areas there must be a nodal axis, or line, which is practically stable, where no motion of any consequence takes place. The elasticity of the crust furthermore requires a return movement following the removal of the depressing agency, a rebound which does

[1] The very magnitude of the glacial phenomenon in connection with its diversity suggests that it is not due to a single cause but to a concurrence of many factors. It may be easy enough to reduce *ad absurdum* every one of the various theories which would account for the whole phenomenon by the assumption of a single cause, but it seems possible that a combination of the various theories, meteorological, geographical, and astronomical may be effected in such a way as to frame a plausible working hypothesis. If all the different causes functioned together towards the same end, it would not be necessary to work each of them to its extreme, and, therefore, often absurd, limit. It might then be unnecessary to move the north pole so very far out of its place as would be required if a change of the earth's axis were regarded as the whole solution of the question, nor would it be necessary to assume such extreme changes of level as 1,000 to 2,500 sea-meters, if the height of the land were alone to account for the fall of temperature. Neither would it then be imperative to postulate that an unbroken land bridge between Scotland and Greenland absolutely shut off the Arctic Ocean from the Atlantic, nor to lower to any very great degree either the temperature or the volume of the Gulf Stream.

not cease on reaching the former level of equilibrium but continues proportionally to the amount of the original pressure. A reciprocal motion is thus set up in the earth's crust, the oscillations of which gradually become smaller and smaller.[1]

Among the many complications which would arise from a considerable change of level in the North Atlantic one of the most important would undoubtedly be the interference with the poleward transmission of warm water, a phenomenon for which we retain the convenient name of the Gulf Stream. A deflection of this flow, which should materially diminish the amount of the warmer water passing into that part of the north Atlantic Ocean lying north and east of a line between Scotland and Iceland might unquestionably bring about changes in the atmospheric conditions which would be both considerable and far-reaching, producing ice-age conditions there and in the countries adjacent.

Taking this for granted and starting from this as our fundamental axiom we may then imagine the following sequence of events in the region we have discussed.

Biologists as well as geologists are now fairly well agreed that the latter part of the Tertiary was characterized by a general elevation of the land considerably higher than now,[2] the result of a gradual rise.

In our region the rise continued until reaching the 600 sea-meter[3] level, thus shutting off the Gulf Stream from the North Atlantic by a land bridge connecting Scotland with the Færöes and Iceland though probably not extending to Greenland. The combination of such a great elevation, the cold due to the deflection of the warm current, and the increased volume of the cold Greenland current produced atmospheric changes resulting in the glaciation which gave Norway

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[1] See N. O. Holst, Bidrag til Kännedomen om Östersjöns och Bottniska Vikens Postglaciala Geologi, in *Sveriges Geol. Unders.*, Ser. C, No. 180, 1899, pp. 113–128, especially p. 127.

[2] Say, on an average, 200 meters. See H. F. Osborn's map, *Science* (n. s.), XI, April 13, 1900, p. 564.

[3] The abolition of the old units of fathom and foot for the meter often results in obscurity or awkwardness in discussions of this kind, in as much as it is nearly always necessary to state whether the figures signify depths below the present sea level or heights above it. To avoid much confusion I have, therefore, employed the terms sea-meter and land-meter for the relative depth and height in question. Thus when I say that the land was raised 100 sea-meters, I mean that the sea-level was lowered 100 meters below its present stand, and when I say that the land was depressed 100 land-meters I mean that sea-level then was 100 meters higher than at present.

HYPSOGRAPHIC MAP OF NORTHWESTERN EUROPE AND ADJACENT SEAS. (FROM SVENSKA HYDROGRAFISK-BIOLOGISKA KOMMISSIONENS SKRIFTER)

a climate and ice conditions like Greenland and allowed glaciers from Scandinavia to descend upon Shetland and Scotland across the land now occupied by the North Sea. When the ice-cap had reached its maximum its weight counteracted the force causing the upward movement of the earth's crust, and finally overcoming it effected a downward movement. The rate of depression was probably not so great in our region as further east and south. It must be remembered that western Norway and Scotland were on the periphery of the ice-cap, the apex and greatest mass of which was considerably to the eastward. Suppose that this uneven depression resulted in such a tilting that the sea-level in the west of Norway and Scotland stood at the present 200 sea-meter curve, while to the east and south of Scandinavia it had already reached the present 200 land-meter level. At this stage in the west we would have western Norway still united with Scotland and Ireland,[1] but elevated only 200 meters more than now. The northeastward flow of the warmer Atlantic water would consequently have resumed its normal course long ago through the Færöe Channel, and the climate would be considerably ameliorated, especially along the extreme southwestern coast-line.[2] To the east and south of Scandinavia, as we have supposed above, the land was depressed at least 100 and possibly 200 sea-meters. But this depression meant the melting off of the peripheral eastern part of the ice-cap and the transgression of the Arctic Ocean over parts of northern Russia and northern Germany in its place, with an Arctic current coming down along the eastern base of Scandinavia, a veritable Hudson Bay with a corresponding climate. Scandinavia united in the west with Scotland and Ireland formed then an elongated narrow island, the western and northern coast of which were washed by the warm Atlantic waters, the eastern and southern by the Arctic cold current. While previously the ice-cap had been melting due to the relative subsidence and the resumption of the Gulf Stream, the arrival of the Arctic Sea on the east side would cause an increase of precipitation. The result would be a recrudescence of the glaciation and a notable acceleration of the depression, a stage corresponding to the second, or Baltic, glaciation of most Scandinavian geologists, the neoglaciation of Hansen.

[1] Something like Scharff's map, Hist. Europ. Fauna, 1899, p. 126.

[2] The hardier portion of the Færöe flora may have reached these islands before the channel had been reopened, while the temperate species followed later, as suggested on p. 491.

Scharff's "Arctic" migration and the red deer (as well as man) had already reached Scotland from central Europe by this time, when the road behind them was shut off. From here they invaded Ireland and later Norway.

Assuming that it has been made to appear probable that the "Atlantic" element of the west Norway biota invaded that country from Scotland, there is yet another question which must be considered, viz., did these plants and animals come simultaneously, or do they belong to two different invasions? Many of the plants require rather diverse climatic conditions, and so do some of the animals. Assuredly, the red deer and the lemming do not belong to the same life zone! Nevertheless, there does not seem to be any good reason why the land bridge in question could not have presented climatal conditions sufficiently different for the two (adjacent) life zones. We have presupposed a warm current laving its western shore and a more or less cold sea limiting it on the east, thus creating conditions extreme enough for our purpose. Of course, if there were two separate land connections, one before and the other after the neoglacial maximum, the problem of the two life zones would be correspondingly simplified.

It should be clearly understood that by avoiding the term "interglacial" in the discussion of the existence of a Scoto-Norwegian land bridge since the megaglacial maximum I have tried to keep out of any controversy over the question whether there were more than one glacial period in Scandinavia. As far as west Norway is concerned it appears to me that the probability is against two separate and distinct glaciations interrupted by a long period of mild climatic conditions. From the character of the animals and plants whose occurrence in western Norway I am attributing to an invasion following the megaglacial maximum and preceding that of the neoglacial stage, the conclusion may be drawn that the climate, even along the west coast of the land bridge, was not milder than that of the present time, but that, on the whole, it had a more continental character owing to the greater land area to the west. With the depression of the land, from having stood so high as to shut off the Gulf Stream, to a level of say 200 sea-meters, and the consequent reappearance of that temperating agency, an amelioration of the climate must have taken place, but while the glaciers retreated somewhat into the interior, it does not seem likely that they left the coast altogether. At the Norwegian end of the land bridge we may perhaps have had conditions similar to those of Norway under the Arctic circle or like those in the Mt. Elias region of Alaska at the present time, while from the interior vast glaciers, much larger than Justedalsbræ or Folgefonn to-day, sent occasional arms to the sea. The neoglacial increase there may then be regarded only as a recrud-

escence of glacial activity, a mere hump on the downward curve of the general decline from the megaglacial apex. It may have been due not so much to a lowering of temperature as to additional precipitation caused by the increase of the area of the sea to the east as the land sank more rapidly and deeper in that direction. If such be the case, it may only cause confusion to apply the term "interglacial"[1] to this particular stage which may not be synchronous with similar, but more protracted and better differentiated intervals elsewhere.[2] There are certain indications that the phenomena of rise and fall, severe and mild climatic conditions, along the northwestern periphery and those in the south and east, so far from being simultaneous, may have been alternating.

This reservation is necessary since the land bridge alluded to above corresponds to the stage hinted at as "interglacial" by Brögger (Norges Geol. Undersög., No. 31, 1900, p. 105; Norge i 19 Aarhundr. I, 1900, p. 23) by Hansen (Landn. Norge, 1904, p. 281 seqv.), and by Wille (*Nyt Mag. Naturv.* XLIII, 1905, p. 332). Whether the Scotch invasion can be assumed to have taken place during this period and the animals and plants survived the neoglaciation depends, of course, on whether the climate during the latter can be supposed to have been temperate enough for all the species, a question to be discussed further on (p. 510). I myself am inclined to the opinion that it was, and that the whole biota continued its existence in western and northwestern Norway throughout the neoglacial stage, but I admit that there is a possibility of a reëstablishment of the land bridge in postglacial times. The following considerations explain the train of reasoning upon which such a possibility appears plausible.

After the ice of the second glaciation began to melt off, the unburdened land started to rise again. The Swedish geologists have shown that in eastern and southern Sweden this elevation so far from being uniform was interrupted by long periods of repeated and gradually decreasing submergences, the maxima of which show considerable changes of level, thus the *Ancylus* depression reached

[1] If the term be only used according to its original significance to any period between two glacial maxima, there can be no objection to its use, but the common application of it more specifically to layers intercalated between two glacial deposits or moraines renders its use in the present connection inexpedient.

[2] It is worthy of note in connection with the above, that *warm* "interglacial" stages are now being discredited even in Scotland. See J. F. Jamieson, On the Interglacial Question, in *Geol. Mag.* (5), III, December, 1906, pp. 534–536.

"more than 200 m. (?) and the *Littorina* depression about 100 m.,"[1] with a corresponding rise between. In southern Norway, *i. e.,* along the coasts of Skagerak, these oscillations apparently have been comparatively insignificant. Professor W. C. Brögger, in his recent admirable publications on the changes of level in this region[2] sees but doubtful indications of the *Ancylus* depression in Norway (Nivaafor., p. 645) and the *Littorina* depression he finds amounted to only 2 to 3 meters at Kristiania (Strandlin., p. 99), a result which he characterizes as only "a halt or a discontinuance of the rise accompanied by a slight depression." Holmboe[3] and Oeyen[4] have also ascertained a slight depression on Jæderen (8–16 meters) though it appears to me somewhat doubtful if this is absolutely synchronous with the other.

These depressions which in eastern Sweden were so considerable must have had their corresponding rise elsewhere, and as Kristiania, according to the above, was near the nodal axis of the reciprocal movement, it is reasonable to suppose that the rise on the other side of this line must have been correspondingly conspicuous along the west coast of Norway north of 60° north latitude. A maximum rise of 200 sea-meters at the western edge of the coast platform corresponding to and approximately synchronous with the *Ancylus* depression would therefore appear to be within the possibilities. Such a rise[5] would restore the connection with Scotland and furnish easy means for the red deer and the corresponding portion of the Atlantic biota to pass over to west Norway.

It is not to be expected that such a theory will receive the sanction of all the geologists. There is a considerable amount of disagreement among them as to the interpretation of the various phases of the glacial epoch, its climatic and physiographic features. There

[1] N. O. Holst, Bidr. Östersj. Bottn. Vik. Postglac. Geol., 1899, p. 127.

[2] Om de Senglaciale og Postglaciale Nivaaforandringer i Kristianiafeltet (Kristiania, 1900–1901; xii + 732 pp. + xix pls.); Strandliniens Beliggenhed under Stenalderen i det Sydöstlige Norge (Kristiania, 1905; viii + 340 pp. + xiii pls.) (= Norges Geologiske Undersögelse, Nos. 31 and 41).

[3] Jens Holmboe, Planterester i Norske Torvmyrer, in *Kristiania Vidensk. Selsk. Skr.,* 1903, I, No. 2, p. 11.

[4] P. A. Oeyen, Tapes-niveauet paa Jæderen, in *Kristiania Vidensk. Selsk. Skr.,* 1903, I, No. 7, p. 44.

[5] This rise would consequently be represented in the extreme west by Jensen's Færöe banks (in Norges Geol. Unders., No. 31, 1900, pp. 106–107) and by the Rockall bank which Professor T. R. Jones, following Geikie, considers postglacial (Notes on Rockall Island and Bank, in *Trans. Roy. Irish Acad.,* XXXI, pt. iii, 1897, p. 97).

are authorities who recognize up to six different glacial periods, or stages, with corresponding interglacial times, while others refuse to recognize more than one glacial period, denying the existence of an interglacial epoch, and so forth. Probably most of these opposing contentions are more or less reconcilable, if not given too wide an application. Even a glacial climate is not uniform over such a vast territory as is here involved, nor are the heavings of the earth's crust uniform. The whole question is exceedingly complicated, as one set of phenomena may cause diametrically opposite results in different places, because the combination with other important factors is so utterly unlike.

One is forcibly struck by this when considering the results obtained by the geologists who have worked out the Baltic situation in Sweden and the closely related conditions in Denmark and southeastern Norway. But to conclude that the same series of events must have obtained everywhere else is to frame a Procrustes bed upon which scientific truth may suffer. Such reflections naturally present themselves when comparing these results with others, say for instance, with those which the celebrated author of "The Great Ice Age," J. Geikie, has arrived at in Scotland. If we compare his views of the sequence of postglacial events in the latter country with those of the Scandinavian geologists we are at once facing the discrepancy that the latter refer the warmer periods to the times of greatest depression, while with him elevation and mild climate, submergence and cold conditions are coincident. In the latest we have from him on the subject[1] this is very forcefully maintained. It is not difficult to imagine, however, that conditions causing certain climatic changes in the Baltic may have had other results in Scotland, and it is therefore plain that the events such as rise and fall of the land, continental or oceanic climates, etc., in the two areas are not necessarily synchronous. If in Scotland we find a succession consisting of a rise, a depression and a rise again, and we find a similar succession in southern Sweden, there is no *a priori necessity* for considering these movements having occurred simultaneously, they may have taken place alternately, that is, the rise in Scotland may have obtained at the time when the land was sinking

[1] James Geikie, On the So-called "Postglacial Formations" of Scotland, in *Jour. Geol.*, XIV, November–December, 1906, pp. 668–682; succession on pp. 675–676. In an article by Lewis, on "The History of the Scottish Peat Moors and their Relation to the Glacial Period," *Scott. Geogr. Mag.*, XXII, May, 1906, p. 252, Geikie has also a "Succession of the Later Glacial and Interglacial Stages in Scotland."

in Scania, and the rise here may correspond to the fall there. And with the climate as with the earth's movements, there are no *a priori* reasons why it might not be mild on the west coast of Scotland at a time when the temperature was rigorous in the Baltic, and vice versa.

But if this is true of Scotland, it is also true of western and northwestern Norway. This part of the latter country is so much nearer to Scotland than to the Baltic and its geological relation to Scotland so much more intimate than to southeastern Sweden that it is much more probable that the glacial events in west Norway were more nearly coextensive in time and degree with those of Scotland than with those of Sweden. Add to this that both the former countries are subject to much the same conditions influencing the climate and that both formed the extreme western edge of the glaciated area, and we are prepared for similar events on both sides of the northern part of the North Sea.

These considerations harmonize very well with the conclusions to be derived from the gradual diminution of the *Ancylus* and *Littorina* depressions towards western Norway, and it seems therefore justifiable to synchronize the Scotch and west Norway postglacial events and to assume that together the two countries went through the reciprocal movements which hinged along a nodal line (not necessarily, or even probably, a straight line) near Kristiania.

Geikie's Mecklenburgian, or fourth glacial stage, the district moraine stage, is by him identified with the Baltic glacier stage (Ice Age, pl. XI), the second or last glacial period, neoglacial period, etc., of the Scandinavian geologists. This period was characterized in Scotland by a submergence (110 to 135 feet, 33 to 41 meters), arctic climate and a land area of greater extent than now. His map of "Europe after the epoch of the last great Baltic glacier" (Ice Age, pl. XII) shows that at this time he considered Scotland and west Norway to be land-connected. It is probably safe to synchronize this rise in Scotland with the elevation during the second glaciation which Brögger (Norge i det Nittende Aarhundrede, I, 1900, p. 23) alludes to as follows: "During the last glaciation the land has probably again risen at least a couple of hundred meters higher than now. This is demonstrated by the occurrence of beach gravel and beach shells on the fishing banks (Storeggen, etc.) off the [west] coast [of Norway] down to a depth of a couple of hundred meters." He continues (p. 24): "Even at the beginning of the period of the formation of the ras [the large terminal moraines along the south-

eastern coasts of Norway] (the ra period, Baltic ice period) the land cannot have been lower than now, but sank afterwards during their formation continually deeper, possibly to a depth about 90 to 100 meters lower than now (at Moss)." The idea that the Scandinavian inland ice in western Norway did not extend beyond the heads of the fjords during any time of the second glaciation seems to be gaining ground among the Norwegian geologists,[1] and if I am correct in connecting the ice-free border land with Geikie's Forestian Scotland, we have a satisfactory explanation of the milder climate and the survival of the Scoto-Atlantic biota from the previous period.

The depression lasted a very long time in eastern Norway, but finally the land began slowly to rise there as the ice cap of the second glaciation melted away. As a concomitant event Scotland and the Scoto-Norwegian land bridge was submerged, Geikie's Lower Turbarian stage, Scotland sinking to 45 to 50 feet (14 to 15 meters) below present level, and the climate became cold and wet.

In the farther southern and eastern portion of the Scandinavian peninsula another depression then took place, the so-called *Ancylus* depression, followed by another considerable rise, the *Ancylus* rise, during which the Baltic became a lake, the *Ancylus* lake. The climate there became warmer.

In eastern Norway, as we have seen, there is no clear indication of this depression and rise to the east, but the reciprocal movement may well have been manifest in west Norway without having been demonstrated there as yet, for in Scotland there are signs of the reciprocity stages of rise and depression, the Upper Forestian stage with its dry and congenial climate representing the rise more or less synchronous with the *Ancylus* depression, and the Upper Turbarian stage, somewhat cold and wet, representing the depression (25 to 30 feet, 8 to 9 meters) synchronous with the *Ancylus* lake elevation.

The subsequent rise in Scotland must then have begun during the Baltic *Littorina* depression. By this time the gradually decreasing movements resulting from the original pressure of the megaglacial ice-cap had become so feeble that they may have left no trace at the extreme periphery of the area affected.

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[1] Even Brögger (Norges Geol. Unders., No. 31, 1900, p. 104) admits that "it is therefore probable that during the last great glaciation at least *portions* of the west coast [of Norway, particularly mouth of the Sognefjord] may have been ice-free."

The question next arises: If the Scoto-Norwegian land bridge only existed before the maximum of the second glaciation, could the animals and plants have survived the latter period on the ice-free coast border along western and northwestern Norway? Hansen (Landnaam i Norge, 1904, p. 288) comes to the conclusion that the yearly temperature at the very edge of the neoglacial time cannot have been more than 6° to 8° C. lower than at present, while farther away from the ice it probably was only 5° to 6° lower.

Of the species composing the biota involved probably none requires a more temperate climate than the red deer, and it is therefore sufficient to inquire into the possibility of this species surviving. The yearly isotherm of the present habitat of *Cervus atlanticus* in Norway is about + 6° C. Consequently the inquiry may be formulated as to whether there is reason to suppose that this deer could have survived, if the yearly temperature of the coast strip during neoglacial time was say 7° C. lower than now, or about — 1° C? It is well to bear in mind that the distribution of an animal like the deer is not affected so much by the annual temperature as by that of the six hottest weeks of the year, approximately equaling the temperature of the month of July. The average temperature for July in the present habitat of *Cervus atlanticus* is about + 13° C. There are plenty of climates having this July isotherm combined with an annual isotherm of — 1° C. Such a climate would of course have a much lower isotherm for January than that of western Norway, which is + 1° C. The mean temperature of January in such a climate might fall as low as — 8° C. Now, can the deer live in a climate indicated by the latter isotherm, and do we know of any region where a species of *Cervus* related to *C. atlanticus* really exists under such conditions? In reply to these questions it is only necessary to refer to the distribution of the central European forms of *C. elaphus* in eastern Europe and it will be seen that the January isotherm of — 8° C. indicates the southern limit of the range rather than the northern. It may be objected that in this case we have to do with an extreme continental climate not likely to have obtained in west Norway even during the neoglacial period. It is not difficult, however, to point out some coast with temperatures essentially agreeing with those indicated above and where a form of red deer flourishes at the present day. Such a territory, for instance, is found along the east shore of the Gulf of Tartary from Vladivostok northwards nearly to the mouth of the Amur (only the January isotherm is considerably *lower* than — 8° C.) and here a

deer, *C. luehdorffi,* occurs, which on the Pacific coast plays the same rôle relative to the common central Asiatic ancestral stock of *C. elaphus* as does *C. atlanticus* on the Atlantic coast. That pine, birch, aspen and the other trees which form the forests of the home of the latter also thrive excellently in a climate with a temperature of $-1°$ C. for the year, $+13°$ C. for July, and $-8°$ C. for January, it is scarcely necessary to point out, but it may be emphasized that if the Scoto-Norwegian land bridge existed at the time and in the manner advocated in this paper, then the climate of west Norway must have been considerably more continental than at present.

Finally, the question of the so-called Norwegian Channel, the deep, canyon-like depression, 75 to 100 kilometers wide, skirting the southern and southwestern coast of Norway, calls for a few remarks. At its northern extremity it is slightly deeper than 400 meters; it is shallowest off the mouth of the Hardangerfjord where it is about 275 m., and it is deepest at its eastern end in the Skagerak where it reaches a depth of 700 m. There is as yet no entirely satisfactory explanation of its origin. Probably the most commonly accepted hypothesis is that it was scoured out by an enormous glacier at a time when the sea stood near the 400 sea-meter level. If the west Norwegian glaciers at one time extended to Shetland and Scotland, it must have been previous to the excavation of this channel, as obviously no glacier could cross it at right angles. Somehow, its absolutely unique dimensions and its remarkable curved outline makes one wish for a more convincing theory. The other explanation seems to be, that the surface here has dropped down between an extensive system of faults. In support of this it may be said that the inner deep portions of the channel, the Skagerak, admittedly is such a depressed basin, the settling of which is still in progress as proven by the numerous earthquakes which have their starting point here, the last important one being the great earthquake of October 23, 1904. The fact that the settling still continues would favor the theory that the channel is of recent origin, probably late postglacial, and that therefore the land connection with Scotland and Shetland was uninterrupted by the channel.

There are many obscure points yet to be cleared up and explained, and details respecting the various elevation stages may never be obtained, since they are covered by the sea, but I think I may safely claim to have made it appear probable:

1. That if the characteristic and important portion of the animals and plants of west Norway, called the "Atlantic" biota, invaded that country from Scotland, it came by way of a land bridge connecting northern Scotland with western Norway north of 59° north latitude.

2. That this land bridge existed after the first (Scandinavian) great glaciation.

3. That part of this biota surely survived the second (Scandinavian) glaciation along the west coast of Norway, and that possibly the climate was not too severe for all to survive.

4. That there is a possibility of a reestablishment of the land bridge during the "Upper Forestrian" stage with its congenial, more continental climate, during which the tenderer species may have immigrated, in case it should be proven that they could not have come with the hardier ones.

X. Summary

The biota of west Norway between the parallels of 59° and 63° north latitude is composed of several elements, an important portion of which must have come from Scotland.

Some of the most conspicuous members of this biota are even at the present time confined to this coastal region, while others of somewhat wider distribution clearly point to the same coast as their secondary center of dispersal. Numerous other species not modified specifically, or subspecifically, probably accompanied this peculiar biota, a fact which cannot be proven at present on account of the defective status of our knowledge.

This so-called "Atlantic" and "Arctatlantic" biota consists of a large number of species, among which the following are some of the more conspicuous:

(*a*) The whole floral element, termed the "Atlantic plants" by Blytt, consisting of about 60 species of vascular plants, 27 species of hepaticæ, etc.

(*b*) That portion of the Scandinavian "Arctic" plants designated in this paper as the "Arctatlantic" floral element.

(*c*) A number of terrestrial invertebrate animals such as *Helix* (*Tachea*) *nemoralis*, among molluscs; several species of *Helodrilus*, among the earthworms; *Ligyda oceanica*, among the isopod crustaceans; *Aporophyla nigra*, among the noctuid moths; *Bombus smittianus*, among the bumblebees, and a whole series of "Atlantic" lepidoptera, hemiptera, and coleoptera.

(*d*) A restricted littoral fauna, among the vertebrates represented by the shanny (*Blennius pholis*).

(*e*) A number of non-marine birds, such as the ptarmigan (*Lagopus mutus*), the rock dove (*Columba livia*), the rock pipit (*Anthus petrosus*), the twite (*Cannabina flavirostris*), and possibly the dipper (*Cinclus cinclus*).

(*f*) A number of terrestrial mammals, such as the variable hare (*Lepus timidus*), the lemming (*Lemmus lemmus*), the red-backed field mouse (*Evotomys norvegicus*), the wild reindeer (*Rangifer torandus*), the red deer (*Cervus atlanticus*), and the fjord-horse (*Eqvus celticus*), either wild or domesticated. To this category must also be added the extinct mammoth (*Elephas primigenius*).

It is contended that the mammalian element of the fauna offers a fairly conclusive proof of a continuous land bridge between northern Scotland and west Norway, and geological considerations have been adduced to establish the probability of the existence of this land bridge during the time between the two phases of the glacial epoch known to the Scandinavian geologists as the first and second glaciations, a stage alluded to by many of them as *the* interglacial period.

I have furthermore attempted to make it appear probable that the climatic conditions in west Norway during the second glaciation were not severe enough to preclude the survival there of this biota, although the possibility of a reestablishment of the land connection with Scotland and a consequent second Scotch invasion during the postglacial stage is not absolutely denied.

MANNERS AND CUSTOMS OF THE TAGBANUAS AND OTHER TRIBES OF THE ISLAND OF PALAWAN, PHILIPPINES

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Translated from the Original Spanish Manuscript by

Mrs. Edw. Y. Miller

The island of Palawan (native and present name) or Paragua (Spanish) is the western and southwesternmost and one of the largest of the Philippine archipelago, extending northeast and southwest between lat. 8° 22′ N. and 11° 25′ N. and east and west between lon. 117° 9′ E. and 119° 43′ E. The island is 278 miles long and from 4½ to 17 miles in width, with an area of 4,726 square miles, lacking 200 square miles of the area of the State of Connecticut. A system of mountains begins at Caluit with a summit 2,230 ft. high in the extreme north and follows the trend of the coast, reaching an elevation of 6,843 ft. at Mantalingahan peak in the south, and maintaining an average from 2,500 to 3,000 ft. throughout.

The rivers of the island are fed by the mountains and turned by their respective slopes east and west, being only eight or ten miles in length. Though unimportant from a hydrographical point of view, they are of great value as a means of communication between the two coasts. Should advantage not be taken of the river courses as a natural route of travel, a long and hazardous voyage would be necessary in frail boats in constant danger from heavy gales during the two monsoons. The fertile soil gives little evidence of the great riches of the island both agricultural and forestal, for its resources have not been developed. The slight amount of wood cut, notwithstanding the various concessions granted in this locality, and the annual harvests of rice are but slight indications of the undeveloped riches of the land. The harvests of rice, though of a most excellent quality, are scarcely sufficient to satisfy the most urgent necessities of the poor and miserable inhabitants, who in the majority of cases nourish themselves with various tubers found in the woods, or planted by the natives.

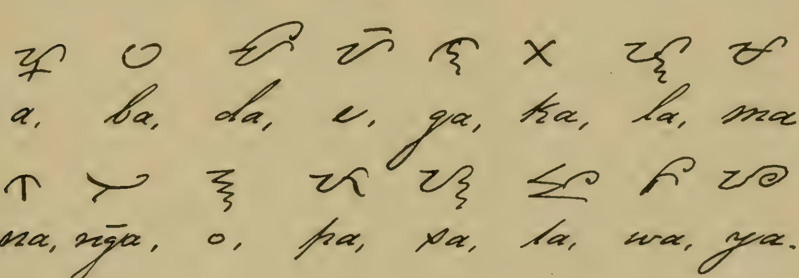
In November, 1904, the Insular Government established in the barrio of Iwahig (now Iualit settlement), in the Bay of Puerto Princesa, a penal colony consisting of a superintendent, one assistant and more than 300 prisoners. They began to clear off and develop the soil, to plant rice, corn, and vegetables and notwithstanding the short space of time since the establishment of the colony it can be said that progress has already been made; for even now they are beginning to avail themselves of the products, especially the vegetables.

Apart from the Christian population in the northern part of the island and not exceeding 8,497 souls, and the Mohammedans more or less numerous, who dwell along the coasts of the southern part, the aborigines may be classified into five groups. They are the following:

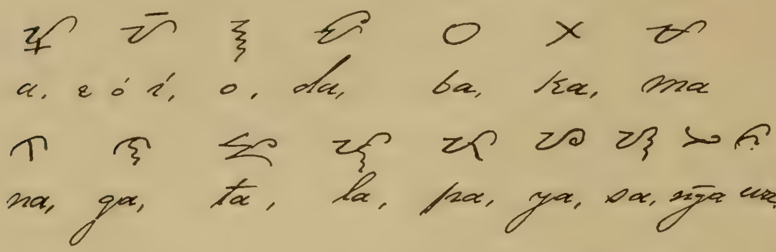
TAGBANUAS APURAHUANOS

This tribe is probably the most numerous in the island, occupying almost the entire central part, including the eastern and western coasts. The principal rancherias on the eastern coast are Iwahig, Ira-an, Aborlan, and Tigman; on the western coast, Virong, Apurahuan, Apitpitan, and Napsahan in the south. Their dialect differs from that of the semicivilized Tagbanuas and the Christians of the north.

Of the five tribes occupying the southern part of the island and a small portion of the north, the Apurahuanos who live in the rancherias enumerated above are the only ones meriting any special mention. They are mild, gentle, and courteous in their trading. Besides, they are the only ones who know and use a peculiar writing similar to that formerly employed by the Tagalos of Luzon. In order to form an exact idea of the construction of these letters or characters which the Tagbanuas Apurahuanos (the same as Inagahuanos) use in their writing, there are placed in succession the signs composing the alphabet.

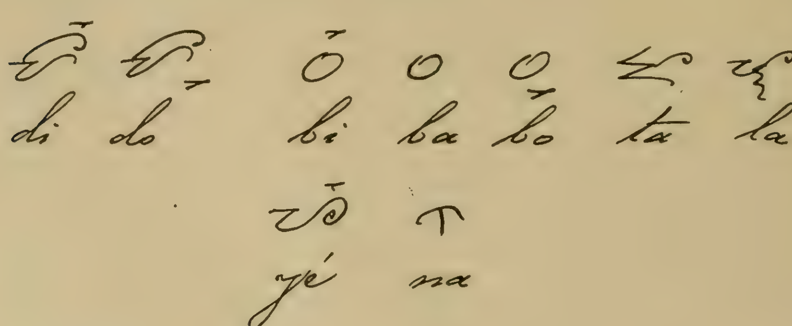


The true position of this alphabet as far as I have been able to observe in the various writings of this tribe is as follows:



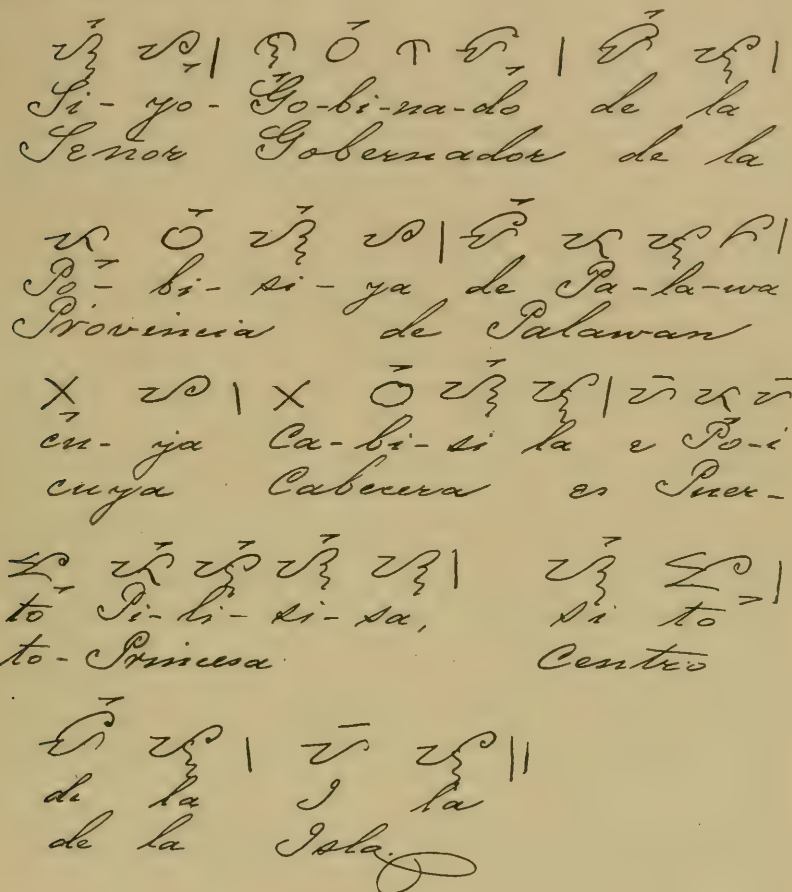
The first three corresponding to "a," "eói," and "o" and the last letter "ua," are vowels and do not admit of any variation in their denomination; while the remaining fourteen composed of semi-vowels and consonants, form different sounds, according to the triangular-shaped mark placed either above or below the character and which is an essential part of each of these characters. The rules of orthography of this writing demand this in order to express in a clear manner when the character should be read "bi, la, ba," or when it should be "bo," for the characters are words and not a real alphabet. The use of the triangular mark is indispensable. Without it, it would be impossible to form entire phrases and complete words easily understood. For the better comprehension of the reader we will illustrate with a simple example.

As has been seen above, the natural denominations of these letters composed of consonants and semi-vowels are: "ba-ba" to express our "b"; "da-da" to express our "d." However if the triangular mark is placed above these characters it then will be "bi, di"; if it is placed below, the sound then becomes "bo, do."



The Tagbanua alphabet lacks the letters c, f, i, g, ll, q, r, v, x, z, of the Spanish alphabet and for this reason the sound of the word

is not only harsh but even appears to cause confusion among the Tagbanuas themselves who speak this dialect, as will be observed in the following example:



We see from the above example that the letter "i" very frequently is substituted for "r." In my opinion it is very necessary to know the language of this tribe in order to understand the alphabet. We need not give further illustrations, for these are sufficient. We will now speak of the manners and customs of the people.

The continual contact of this tribe with the Moros of the south during a period of many years has caused them to clothe themselves in a manner similar to the Moros. The women, however, do not wear the trousers as the Moro women do, but they wear the patadiong of the Christians of the north of the island.

The arms, generally, are the blow-gun and arrow, in the use of which those who live in the interior are very skilled. Those who live along the coast use "armas blancas" such as the "badon" or Moro kris and the spear, and there are some who use a musket of very old pattern. With these arms they defended themselves against the attacks of the Moro pirates from Jolo and Mindanao as well as from the Moros of southern Palawan. These attacks occurred very frequently during the years when Moro piracy reigned in nearly every part of the Philippine Archipelago and hostile incursions did not cease until the year 1876 when, thanks to the efficient forces of General Malcampo (of grateful memory) then the Spanish Governor of the Philippines, Jolo was taken.

The character of this tribe is very peaceful in its dealings and very hospitable. There is never war among them, neither does one rancheria rise against another. All dissensions among themselves are settled by the maguegares (nobles) or old men who exercise authority and who form a kind of council in which they hear and judge all the cases submitted to them. Of the order of hierarchy of these maguerares we will speak later.

When they receive into their home any stranger of distinction, especially one in authority, they endeavor to please him in every possible way. The young women are resplendent in their best attire, especially the wives of the chief, who usually has two, polygamy being permitted. The rich men of the tribe, those in authority, and the head men of the rancherias, always hold in reserve certain objects such as cups, plates, glasses, bowls, which they carefully guard, using them only on occasions when strangers of some pretence may present themselves. When visitors are entertained, on the table of the aristocrat is boiled rice placed upon a large metal dish, yellow in color and known as jalam, surrounding this are the bowls known as barong, containing meat, salt, and various foods prepared according to the mode of the country. A large metal basin holding water, and which at times serves as a finger bowl, is placed upon the table and into it is dipped the glass with which to take the water. Each large plate or jalam prepared in the way described is for the use of one person only, thus obliging each noble or maguegar to provide himself with a number of jalams and large metal cups. These objects are of great value to the owners and are bought from the Moros at a price more or less dear, giving in exchange for them almaciga, wax, and bejuco which they gather from the mountains. There are no dining tables, but the guests sit upon the floor. Be-

cause of a feeling of embarrassment or shame neither the host nor any member of his family will dine with the visitors, except on rare occasions when it has happened that the visit has been repeated.

The dinner being finished, the guests rise and each betakes himself to whatever part of the house pleases him. Immediately the hostess who during the time the guests were eating was preparing the betel, presents herself to each one with the salapa in hand containing buyo, lime, and tobacco, and invites them to partake—which invitation is received with much pleasure. This being done they begin to jest with one another, some reclining, others seated, thus at times passing an entire day in friendly intercouse.

Civil Hierarchy of the Tagbanuas of Apurahuan and Inagahuan

Masicampo, chief of all the rancherias.

Panlima, local chief of a rancheria.

Maradia, noble and member of the council.

Orangcaya, noble and member of the council.

Satia, noble and member of the council.

Pangara, noble and member of the council.

Moladi, noble and member of the council.

Lacsama, a kind of administrator in whose house the nobles and plebeians of the tribe meet whenever they have important matters to consider.

Paracasa, a kind of constable or agent whose duty is to make known the orders of the chief of the tribe. The command in which it is necessary to unite for business or council is known as Suriguiden.

All the offices mentioned above are hereditary in the same family. In case of the incapacity of the presumptive heir the office passes to another person either of the same family or not, usually, however, one of the brothers succeeds the incapable heir, thus keeping the privileges of office always in the same family.

Government and Administration of Justice

The government of the tribe rests in the hands of the superior chief, or masicampo, and the nobles who constitute a Supreme Court. Each rancheria, however, is governed by its chief, or panlima, who together with the men of authority of the rancheria hear in the first instance the cases of little moment which occur within their jurisdiction. The decision of the chief is usually respected; although there

have been cases in which the litigants, not satisfied with the sentence pronounced by their chief, appealed to the supreme tribunal at which presides the masicampo and from which there is no appeal. This chief and the nobles possess certain life privileges. They are not ostentatious and do not have the manner of the wise and high dignitaries of the Moros, whom it is not possible to approach and to whom it is not allowed to speak without kneeling, bowing the head, and kissing the feet scarcely daring to face the interlocutor. On the contrary the masicampo, when he has to decide a question, speaks gently to the defendant and complainant, commands them to be seated before him and the nobles who compose the court, listens attentively to the complaints of each one and after due consideration of the question, pronounces sentence in conformity with the nobles, the old men, and the plebeian class who are present.

The litigants receive the judgment with great humility and mildness worthy of their character.

The punishment, or penalty generally imposed upon the guilty, consists of fines and reimbursement known as bandi towards the injured party. This payment is made by giving to him a certain number of large plates of metal, known as talam, various kinds of musical instruments, all of metal, and some earthen jars of different shapes and sizes, the value of which is in proportion to the size. All these objects are admissible by the court in order to cover the fines of the accused.

Corporal punishment rarely takes place. This occurs only when the nature of the crime is such as not to admit of any other less mild and lenient. The chief of the tribes and those who are a part of the court endeavor as far as possible to lessen the criminal liability of the delinquent in order that as light a punishment as possible may be imposed upon him. If at times during the session of this court there be present in the rancheria a stranger of some importance the chief will invite him to take part in the council, giving him the power of speech and a vote and not infrequently will consult his opinion.

Crimes and Punishment

In this tribe are recognized only three classes of crime:

1. Incestuous marriage or union.
2. Murder.
3. Robbery.

The incestuous union of father and daughter, of son and mother, of brother and sister, and of first cousins is the most serious of all

crimes and because of the general indignation of the tribe merits the severest punishment. Those guilty of incest are confined in a cage made of thorny reeds. To them is given a scant portion of food for a limited time. They are then taken to the sea, a discourse is given to the people who have gathered there, exhorting them to be particularly careful not to imitate so detestable and scandalous a crime as that perpetrated by these who in payment for their perversity are about to be cast into the depths of the sea from which they will never again return. The guilty are then hurled forth into the sea.

The crime of murder is punished with a fine or reimbursement not exceeding 500 bandi, the equivalent of 50 pesos. This fine is paid to the family of the deceased. If the murderer should not have sufficient means to pay the full amount of the fine, the family and relatives of the deceased have the right to avenge themselves upon the murderer or any of his relatives. This, however, very rarely occurs, for the relatives of the rancheria from which the murderer comes, in order to avoid so lamentable consequences in their home, contribute according to the resources of each, the amount imposed by the tribunal. In this case the delinquent becomes free of peril; but he is under obligation to pay to each of his countrymen the amount of the fine which they religiously lent to him. Usually a rich man will pay the fine for him with the condition that should the bandi, or its equivalent which the noble has lent to him, not be returned within a specified time, then shall the murderer and his posterity (lineal descent) be declared slaves.

Civil debts are also treated in this manner when the time designated by the creditor has elapsed more than once and the debtor has found no means to pay the debt.

In the case of the crime of murder it is to be noted that in the very same act of the assault or fight, the right of vengeance on the part of the relatives of the deceased is legal as long as the act has not been made known to some chief or maguerar and as long as the delinquent has not sought the protection of the authority. When once this is made public and has become a matter of the council, the right to revenge themselves by force perishes.

Regarding the crime of theft or robbery it is scarcely considered as such, but is held in the light of a minor offence. There exists among them no greater penalty than the restitution of the objects stolen, the author of the crime being called a thief and a person of bad conduct. Should he, however, repeat this fault twice or more

then he shall be punished. Besides restoring the stolen effects to their true owner, he will suffer a heavy fine and even the lash. There always exists the danger that should the thief be surprised in the very act itself by the owner of the objects taken, then will the owner have the legal right to kill the thief, providing always that the person robbed can justify himself with proof of the imputed deed.

Another crime which is considered as a minor offence is adultery. Among us and according to the new law, adultery is a libelous offence, but among the people of this tribe this crime merits no such qualification, since the only punishment is a fine payable by the adulterer, and the restitution of double the quantity of "bandi" which the husband was obliged to pay at his marriage.

This is the case if the woman was very young when she married; but if it be her second marriage then the adulterer need only repay the sum given as the price of her marriage and in addition pay a fine which is determined by the council. In case of inability to pay then shall the woman be restored to the power of the legitimate husband, the abductor or adulterer suffering a light punishment which always is a fine (bandi). The amount imposed by the council and wronged husband being satisfactory, the new mates depart to some other place to spend their honeymoon, leaving the husband dispossessed but with his gains and bandi. If the divorced pair have any property acquired during their married life the tribunal or council decides that the same be divided into equal shares, each one taking his own. The children born of this marriage not only have the right in the participation of the property, but have the liberty to visit their parents at any time and to remain in the power of either one as though nothing scandalous had happened. If the guilty woman is easily moved by love and should desire her true husband and show earnest longing to return to him and he be willing to receive her, the matter can easily be arranged before the council of the tribe without any further procedure than the payment of the regular fine (bandi) and the restitution of the amount of bandi which the second husband had to pay. The result is that a woman may marry a number of men without any loss to her honor, though there are not lacking women who are faithful to their husbands even unto death.

This tribe recognizes a superior being known as Diwata or Mangindusa who is the creator of earth and of men. His dwelling is in the heavens known as Basadcatdibuat. There are two secondary

gods named Angogro and Jaliaqued. The former dwells with Mangindusa the latter occupies "Basadcatyba" the lower heaven. Angogro receives the souls of those who in life did works of charity and meritorious deeds and who had abstained from committing enormous sins and detestable vices. These are placed in a magnificent abode where there are beautiful houses for them and where they hear naught but happy and melodious music. On the contrary Jaliaqued receives the souls of those who having led on this earth a life full of vices and evil deeds too numerous to mention die in mortal sin.

Among the Tagbanuas exists the belief that their god has reserved in Basadcatdibuat picturesque houses surrounded by beautiful gardens and fields prepared for the saints, who have the privilege of ascending and descending to the earth in order to cure the infirmities of their people and to remedy their adversities. For this reason whenever the babailan, the minister or representative on earth of Diwata, is called upon to cure some sickness or to implore the aid of Mangindusa to remedy the afflictions of the tribe such as epidemics, contagious diseases, famine, etc., he never fails to invoke the spirits of the dead who in life had been relatives of the sick. In his supplication he calls upon them by the names by which they had been known while on earth. Usually the babailan is the minister of Diwata Mangindusa and the practitioner of the tribe. The god Diwata is represented by a small bird known as saguay-saguay and which sings a very melodious song known as darait. For this reason, before commencing any work, be it a journey, a healing, a wedding, etc., they invoke the protection of Diwata by means of the small bird saguay-saguay; if, in the act of the invocation, the bird sings it is a sign that Diwata does not approve; in such case the undertaking will be discontinued until another day. If, on the contrary, the bird will not sing, the god then signifies his assent and approbation, thus permitting the undertaking to be carried into effect. When they depart from their houses they observe the same ceremony. If, while putting their feet on the earth the saguay-saguay sings or some one within the houses sneezes, they will return to the house and there remain a few minutes; after a little while, not without imploring Diwata Mangindusa that he liberate them from any danger, they resume their journey. They consider the song of the bird or the sneeze of one of the companions of the house as an omen foretelling perils which await them on the way or at the end of their journey.

The singing of a small lizard called by the Tagbanuas tarectec, in

Cuyon secsec, and in Tagalo butiqui, is considered very sacred even more so than the sneezing of a person. When the tarectec is heard at the moment when some undertaking is begun such as a journey, a marriage, etc., all work ceases and nothing is done for some hours and even days.

Feasts

This tribe celebrates certain feasts on the last three days of the last phase of the moon, or the 7th, 8th and 9th days of the new moon, and the 15th and 16th days of the full moon.

On these feast days any kind of work is allowable, save the tilling of the soil, or the planting of rice or any other plants necessary for the sustenance of life. There are other particular feasts celebrated by the rich, such as the chief of a rancheria and the masicampo, the chief of the tribe. These days are chosen as fancy dictates, always taking care not to select the days of special feasts. These feasts usually take place after the harvest of palay, especially if the yield has been abundant. Two or three months before the celebration of this feast, the family of the chief of the entertaining rancheria and the other rich families begin the preparation of the pangasi. Rice partly hulled is boiled and then allowed to cool on a petate of cane or woven bejuco. When it is thoroughly cooled it is taken up in the hands and mixed with a kind of yeast called tapay, which is made in the following manner:

Wild peppers, the leaf of the buyo, ginger, and the shoots of a certain species of bejuco known as wa-ag are placed proportionately in a mortar and beaten. When crushed this is taken out, put into a piece of linen cloth and squeezed. This liquid is the ferment and together with water is added to the flour made of rice, which had previously been made into a kind of wafer. Afterwards the whole mass is placed in large jars covered with banana leaves. It is allowed to ferment for a time and is not opened until the day of the feast. The longer it remains unopened, the stronger it becomes.

On the day previous to the feast, all the women of the rancheria hull the rice, prepare the dinner, and make the delicacies known as "amit." These tid-bits are made of powdered rice, or malagquit, kneaded with unripe plantanos or wild honey. In all this work none of the men take part unless some of them should have killed a wild boar. They quarter it but do not prepare the food. On the day of the feast the inhabitants of the rancheria and the guests from the neighboring rancherias abandon themselves to the eating of the foods prepared according to a prescribed mode until the setting of

the sun. At night numerous candles of wax and pitch known as saleng are lit, while some of the children of both sexes will make piles of firewood in the yard and light them in order that the sudden blaze may assist to illuminate the interior of the house which as a rule is without walls.

Now the hour of music has arrived. The instruments consist of a certain number of babandiles, sabarangs, and one or two drums of wood, one end of which is covered with monkey skin. This class of drum known as guimbal differs much from ours, its barrel being irregular in form and very long, at times measuring one vara and the covered end being larger than the open one.

When all is ready, every one joins in the dancing and drinking of pangasi, which ceremony is begun by the nobles of the tribe.

The dances are as follows:

The calipandang is danced by one or more women swaying with handkerchiefs in their hands and moving their feet very little. About the women the men dance very rapidly with their hands on their backs as though manacled and forming the figure 8. As may be supposed, they tire very quickly and as the wearied ones withdraw, substitutes take their places until the music ceases.

The guemba-guemba is danced by various women with handkerchiefs in their hands which they wave to the beat of the music. About them are an indeterminate number of men who with hands joined encircle the women as a net, going and coming to the time of the music and their songs.

The tarec is a dance executed by one woman or one man dancing very rapidly, even more rapidly than in the calipandang. This is of a religious character since it is the one danced by the babailan (either man or woman) the representative of Diwata Mangindusa prior to the beginning of a cure for whoever may be sick of the tribe. This dance is performed whenever they wish to give or implore the protection of Diwata in order to foretell to the inhabitants of the rancheria or tribe the terrible effects of an epidemic or other evils that may destroy the town.

If this dance is executed by a man it is not called tarec but quendar.

The dance tagbac is executed by a man with his hands ascending and descending alternately above his head to the beat of the noisy music.

The tambol is danced by a woman holding in her hands the dried leaves of the balasbas (a species of palm) which she moves to the sound of the music. Three or four men dance about the woman.

The sarumay is danced by one woman or one man according to the ability to perform this, the most rapid of all dances.

The tugatac and the taguepat are danced either by one woman or one man so slowly and softly that not even dancers themselves become over-heated.

In all the dances, the women always have the advantage; for the simple reason that they scarcely move their feet and hands; while the movements of the men, besides their hare-like leaps, are so rapid that to continue dancing for any length of time would make them breathless.

While drinking pangasi there is no distinction of position whatever. It is to be understood that this drink cannot be taken out of glasses or cocoanut vessels, but through four small tubes of cañabujo the size of a penholder or large lead pencil. These tubes are put into the jar and touch the interior cover which consists of spikes of palay that serve as a strainer.

After the tubes are withdrawn water is added to the contents of the jar. This operation is repeated as quickly as the water is drained off. Any tao of the tribe can lead the wife of the masicampo himself to the jar, sit with her and drink pangasi. During this ceremony which is usually done by a man and woman, their heads being covered by large handkerchiefs, the man has the privilege of kissing the woman and may be quite familiar. This is done according to a common and traditional custom. There is no jealousy evinced on the part of the husband unless the man should lead the woman to any part not within the house in which the feast is celebrated. Many times an invited noble will return to his house offended because his wife had not been taken by one of his friends to the side of the jar and there partaken of pangasi. Among the invited guests there are not wanting some, who in these diversions not possessing morality and courtesy, become drunk and commit barbarities, thus lacking the respect due to their equals and even the laws and customs of the tribe. When this occurs, the old men unite and sentence the transgressor with a punishment adequate to the circumstances. The guilty one is made a prisoner and is fastened to one of the posts of the house until he has recovered his reason and begged pardon for his crime. If this, however, is not merely a slight offence but takes upon itself the character of a serious crime, then the council on the day following the termination of the feast, will impose a heavy punishment, first securing the person of the transgressor in order that he may not escape.

There is another feast more general and solemn, which is celebrated annually, and known as sagda. This feast occurs in January or February on any day of the moon not otherwise observed.

The day previous to that of the feast, all the families of the tribe without distinction of rank, previously notified by the chief of the rancheria who usually is babailan or the minister of Diwata and who officiates in this ceremony, prepare their food, each person of both sexes in proportion to his ability preparing a small quantity of rice. When all things are ready, the chief of the rancheria or officiating babailan will give the order to begin the departure to the place designated in which to celebrate the feast. This usually takes place in some beautiful part of the beach where the feast is held annually. If this feast takes place upon the beach it is known as "sagda," if on the contrary it is celebrated in the woods or near the seed fields it is called langbay.

"Langbay" is similar to "sagda"; but its celebration occurs in April or May after the palay has been planted.

When the people have come to the chosen place, the minister of Diwata performs the religious ceremonies with great attention on the part of the people. He will begin by giving thanks to Diwata Mangindusa for having preserved their lives, giving unto them a good harvest (if this has been so) and freeing them from contagious infirmities during the year which has just ended; afterwards he will ask that during the year just commencing Diwata Mangindusa may continue to dispense equal favors and benefits, that this year shall produce an abundance of bees, that it may be a happy one for the tribe, and that there may be a good harvest of palay and little sickness. These religious ceremonies of the Babailan being ended, he will then make a small raft of caña bujo which is adorned with streamers of the leaves of bori or balas bas, a species of palm. In each of the four corners of the raft a candle of wax is placed and lighted. The raft is taken to the water and upon it is placed a chicken, buyo, tobacco, cigarettes, each of every kind of dainties prepared by the women, and last of all each person, regardless of sex, places upon the raft a small quantity of rice, the poor giving a lapatan or one fourth of a chupa, the nobles and rich a greater quantity.

The small raft being laden with these articles the babailan will invoke the sacred name of Diwata Magindusa, and will pronounce in their dialect the following words:

"Turona balza at Diwata tabanen at idulong mo cay Mangindusa

ya mga caranen, manoc, pagmama may buegas nga ipagbuis namen cania maya canimo ya manga saraquiten may musang mararaet, matudo lamang ya cagayenan; at cat-taun nga buegayen cami et magayen nga tiempo et putiocan may magayen nga panguma at ipa-alaid ya mararaet nga saraquiten," which translated means:

"Depart small raft to Diwata, bear to him the dainties, the buyo, and tobacco, the chicken and rice which we offer to him and may there go with them the sickness and evil, leaving only the good, that in this year he may give to us many bees, a good harvest of palay and that he may put away from us contagious diseases."

After the departure of the raft they drink pangasi, which is the favorite beverage of the tribe. An old man or the babailan officiating is the first one to break the covering of the drink, followed by the nobles and then the common people.

The feast as has been said, is of a religious character and very solemn. Neither the dance nor any other kind of play or diversion is permitted.

The second feast which they also celebrate with certain solemnity, the "Sangbay," takes place in the month of April or May, two or three weeks after the planting of palay, and which is known as "Tugda." If after the palay has been planted and the heavens deny its beneficiary rains for a time and there be sign of the lack of bees then the tribe gathers and determines upon a day on which the feast of "sangbay" shall take place. This being done, the women prepare the necessary things for the occasion. The day having arrived, they meet in a place designated by the babailan, which generally is a small woods near the rice fields. Hither are brought a pair of chickens with feet bound. Upon arrival the chickens are untied and the large joints cut in order to procure a flow of blood from the wounds. While this is being done the babailan recites the prayers. Presently a hut is constructed. This consists of four posts, the bottom being of woven cane. The structure is uncovered and unadorned. In this cobachito, or hut, the babailan deposits the offerings of the people, which are sweetmeats, buyo, bonga, lime, tobacco, rice, etc. After the ceremony the people return to their homes and enjoy the delicacies of the feast. There is permitted no kind of play or diversion save the drinking of pangasi, which continues through the whole night. I have had occasion to be present, many times, at these feasts having been previously invited by the chief and nobles of the tribe. I could not excuse myself, for to them it is an honor to be able to invite a stranger of some merit whom during the time they might meet in the rancheria.

Manner of Seeking a Wife

When the father of a family sees that his son has arrived at a marriageable age he will call the son to him and tell him that he desires him to marry and asks whether there may be anyone whom he favors. If the son accedes to his father's wishes and designates a woman he desires, the entire family, including the relatives, unanimously begin to decide upon a day when they will visit the house of the intended bride to ask of her parents her hand in marriage. The day having been fixed, the family, according to its circumstances, will send to the family of the chosen one a ring of gold, silver, or copper, an unmistakable sign that that family begs the hand of the woman. The family betake themselves to the home of the sweetheart and there form a committee known as "al-log." The father of the man being accompanied by some old men of the rancheria will open the discussion; he will use endearing expressions that may find favor among those present. He will tell the reason that obliged them to come to the house. This object being already known, the question will then be discussed or the petition refused. In the first case they will unanimously decide the conditions of the wedding and the quantity of the "bandi" which the family of the bride desires, and finally the day of the celebration is chosen. In the second case they are obliged to give an explanation of the motive for the refusal, although this happens very seldom, yet if the father or family of the woman do not wish to accept the proposition of the aspirant, they can not keep possession of the ring which had been sent beforehand.

When the wedding day has arrived the family of the bridegroom and all the old people of the rancheria meet in the house of the bride, taking hither all the necessary articles for the celebration of the wedding such as pangasi, boiled rice, fish, delicacies, etc., etc. When all is ready the babailan will officiate. If, however, there be no babailan among them, an old man of the rancheria who possesses the friendship and confidence of the two families will act as a substitute. The officiating one having previously placed in a cup or small hole in the ground a certain amount of cocoanut oil, will turn his eyes to the heavens in a supplicating manner and will pronounce the following words of the ceremony in Tagbanua:

"Way ini ytao nga magasaua 'Darait' ipagpanauag canimo ay pa buegayan mo naga sira et magayen nga pag asaua at maruay nga panulos et mas que uno unong caquenan nira."

Being translated: "Here are those who are married 'Darait'

unto thee we recommend them in order that thou givest to them a happy union and the facilities to hunt and to meet with those things which are necessary for their life, their prosperity, and their well being."

This being said, he will then place his thumb in the vessel containing the oil and will anoint with it the fore-finger of the groom, touching it from the end of the finger down to the pulse and saying the following words in Tagbanua: "Apiat magayen nga palad," which is to say, "May your good fortune ascend." Afterwards, placing the palm downwards, he will again anoint the same fore-finger, beginning at the pulse and thence to the tip, saying words very similar to the above and which signify "May your bad fortune descend." The bride is similarly anointed. After this ceremony the padrinos (best man and bridesmaid) of the newly wedded pair prepare two plates of boiled rice. Each one will make a ball of rice the size of a hen's egg and hand it to their respective proteges who receive it with great attention and presently exchange it with one another, so that the groom gives his portion of boiled rice to the bride who immediately gives hers in exchange.

When this has been done the wedding ceremony is completed. From this day the groom remains in the house of his father-in-law. He has no right to depart from it, not even to live independently with his wife in another house which they might build. He must always remain with his father-in-law. If the newly married pair are of the rich class and have prepared all that may be necessary for the feast, then, after the ceremony, the guests begin to dance, to eat and to drink pangasi; if, however, the wedded pair are poor, the dance and the feast are omitted.

Polygamy is permitted on the part of men. As has been said before, a man who is rich and who is able to take care of two or more wives is allowed to have them, but he is not permitted to marry them at one time, the marriages taking place one after the other. The first wife is the head of all the others, and they are obliged to assist her in all the work pertaining to the service of the husband and the house. In case of disrespect or disobedience on the part of any of the wives towards the first wife, it is incumbent upon the husband to give the needed reprimand or punishment to the one guilty of the misdemeanor.

As the reader may imagine, the husband, in spite of being a spouse to three or four women, nevertheless is not able to have them all with him at the same time. He is obliged to live with each one

separately, always beginning with the first wife, then the second and so on to the last one. The children born of this kind of marriage have equal rights in the inheritance. Should the first wife remain childless she has the right to adopt any son or daughter of the other wives and whose rights in consequence are legitimate.

Concerning the Mode of Giving Names

When the children of the Tagbanuas are two or three years of age their names are given to them in the following manner:

The child is made to sleep during the day. When thus asleep it is suddenly awakened, being called by the name by which it is to be known. Usually this is the name of some tree, river, or place where the child was born. It may be the name of some animal or insect and there are not wanting those who bear Christian names.

In spite of the strict observances of the marriage ceremony, these prove no obstacles to a woman who may imagine herself in love with another man and desires to live with him, he only being required to pay the necessary amount of bandi.

The bandi varies according to the age of the woman. If she is young then the man will pay to the father-in-law the sum of 500 or 600 bandi, its equivalent being 50 or 60 pesos. Should, however, the groom be a poor man then only half of this amount is demanded. This same amount is also paid for the woman who is somewhat old.

Concerning the Wealth of the Tribe

The riches of this tribe consist of much palay and a great number of vessels of metal and vases, such as agongs, babandiles, sabarangs, salapas, langnay, plates, etc., including money, furniture, and property. He likewise is considered rich who has numerous servants, who, although they do not live with him in the same house, are obliged to follow him whenever he calls them to certain work of his and who are obliged to pay him a certain amount of money or bandi.

Slavery exists among the Tagbanuas. A noble or rich man because of some misfortune on the part of a poor man will pay for him some debt or pressing obligation such as a fine or bandi imposed by the tribunal of the tribe. For this reason, the unfortunate man and his posterity become slaves of the rich man unless by some extraordinary good luck the said slave or one of his descendants is able to pay the ransom of the slave with half the bandi. This is done with mutual accord. Although the word slavery has a terrible signification, it need not cause the reader to interpret it in its actual

sense, for among the Tagbanuas slavery scarcely signifies anything in comparison with that of the Moros, where the slave is a being despised and where the masters are owners of the lives and properties of their slaves. On the contrary, the slaves of the Tagbanuas are like free men. In the majority of cases it is their privilege to obey or refuse to do the mandates of their masters. There have been cases of this kind in which the master desired a certain thing should be done and in which his slave answered that he did not feel so inclined.

I myself have frequently been present at scenes of a similar nature. For this reason, without the fear of being mistaken I would say the government of this people is patriarchial.

Of the Duties of the Babailan, His Double Function as the Minister and the Physician of the Tribe, and His Influence upon the People

The babailan of the rancheria, whether man or woman, is regarded as a sacred and privileged being, the representative of Diwata.

When some epidemic or contagious disease afflicts the people they hasten to the babailan and beg him to intercede with Diwata that he remove from their midst the evil which is assailing them. Then the people will congregate in a certain place designated by the babailan and to this place will take various gifts and perform the religious ceremony which has been previously described.

When a man, woman or child becomes ill the family of the patient will hasten to the babailan who is famous as a doctor. They will beseech him to do them the favor of curing the sick one. After having examined the patient he will command the musical instruments to be brought to the house. When the first hour of the night has come, skilled musicians will play upon these the sabag. To the sound of this the babailan, if a woman, will dance the tarec; if a man, the quendar. During the dance the babailan will attain a state of frenzy, while all about him are quiet, regarding the act with great attention and respect. When the dance is finished, the babailan being restored to a normal condition, will declare to the family of the sick the disease with which he is afflicted, the sickness, as they imagine, being attributed to witchcraft or some other gross superstition. As has been stated when discussing the religious rites, no manner of cure is begun before the invocation to the Diwata. The following morning the babailan will secretly prepare the medicines, usually the roots and leaves of trees.

When everything is ready he will touch some empty metal vessel in order to produce sound, calling and beseeching the departed souls of the family of the patient to help him to cure the afflicted one. The medicine having been applied, the patient and the house in which he dwells is quarantined against those who are not of the family and who have no part in the quendar or tarec. The quarantine may be a matter of one or two weeks according to the prescription of the babailan. In order that no one may be able to feign ignorance, he will place upon the door of the house small leaves of trees which they recognize and close the entrances to the house with cords fastened to small posts. The dance is continued every night. There are other infirmities known as "pintas" among them which are attributed to witchcraft and which the babailan can not cure. These evils are cured by particular persons or soothsayers. The man takes a cow and measures it by means of his arm. Upon the right side of the cow he places a small ball of wax. Before he again measures the animal he asks this question:

"Who has given this infirmity to such an one?" If the ball has not moved from its place he will repeat the question.

"Was it Jack?" If, after the repetition of the act, the ball has moved or fallen, then it signifies that Jack is the author of the evil with which the sick man is afflicted and whom Jack will be obliged to cure, being severely threatened by the family of the afflicted one. Usually the blind credulity of this people will effect a cure. If the babailan cures the afflicted one, he will receive his customary fee, which usually consists of various objects of value, the number of which is mutually settled between him and the family. If the family are rich, they are accustomed to celebrate with a fiesta the successful restoration of health. If, on the contrary, the man dies because of his ailments, the babailan receives naught for his labor.

When a death occurs the entire family break forth into weeping; though the grief may be lessened by the advice of the babailan who encourages them to resign themselves to the will of Diwata. If the death be that of a rich noble, the family and the babailan will immediately spread abroad the sad news to all the people. Should there be any near relatives living in distant rancherias, notices are also sent to these and they are informed that the body will not be interred without their personal assistance. If the deceased be the masicampo, or superior chief himself not only are his own relatives invited who live in distant parts, but also all the local chiefs and nobles of all the rancherias under his command. During the long

illness of the Masicampo Dimas of Inagahuan there assisted him different babailanes, but without any satisfactory results. On the day of his death the sad news was told throughout the town, circulars were sent to the local chiefs, to the dignitaries, and to all the other nobles of the rancherias of his command. The body remained in the house more than three days. Upon the arrival of the relatives the body was buried. Two days after his death his body was placed in a coffin known as lungon, which had been an old baroto and now served as a casket.

The death of this superior chief was communicated to the Spanish governor of this island, at that time Sr. Canga Arguellez, who later sanctioned and approved the nomination of the successor of the dead masicampo.

An hour after the death of a rich noble—especially if he be the superior chief of the tribe—the family and head men of the tribe are accustomed to fire a cannonade to announce the unfortunate event to the people, other cannons are also fired as the body is taken from the house and also when interred. At times, instead of placing the body in the graveyard, the family and head men will place it within a small hut constructed by the people as the last resting place for their chief. This house is placed without the habitation and is surrounded by a strong wooden fence in the manner of a stockade. The burial being finished, the family will place upon the grave objects which he in life had possessed and cherished, such as vessels of metal and crockery, jars, articles of clothing, and jewelry, both of gold and silver. Among this people exists the ancient custom of giving food to the departed spirits. For this reason, the family after having finished the burial, place upon the grave the necessary articles of food, also a pot, glass, a cocoanut cup, and bamboo canes which contain water, which according to their belief the departed spirit drinks whenever he becomes thirsty. For months, even a year, the family will continue to carry food to the grave. After a year has passed, provisions are taken annually.

In olden times and even until ten years ago, objects placed upon the graves were considered sacred. For this reason no Tagbanua ventured to take any of these things lest the departed soul would punish him with a terrible sickness and even at times kill him. But later contact with the whites caused them to value less this traditional custom, and now in order to prevent robbery the family, before placing their offerings upon the grave, bore the large jugs and vases and break the dishes, so that neither the spirit nor those who wish

to rob can utilize them. The burial of the poor is very simple. The custom, however, of placing upon the graves certain objects and provisions is indispensable; and if in life the being had no more than one suit of wearing apparel and a few things, it is very necessary that these must go with him. Today these customs are fast disappearing. My frequent tradings and long residence with this people induce me to think that it would not be difficult to civilize and educate them. Many Tagbanuas of both sexes have proved this. In the barrio of Inagahuan are Tagbanuas whose mode of living and ability to speak Tagalo and Cuyono can scarcely be distinguished from those of the Christians themselves.

The only art worth mentioning is the weaving. The women weave the caña-bujo, bejuco, and a small fiber with which they make small baskets, and large and small tampipes, which are telescoped baskets and take the place of a valise or trunk. With bejuco they weave the wide petates which are known as paypay and used for palay and other domestic purposes. Of the small, fine fiber the women of the north make the cases for cigarettes, buyo, etc. The Tagbanuas and especially the Palawanos of the southern part of the island, weave of the leaf of the bori, pandan, bancuang, and balasan, petates of various colors, although they are not as beautiful as those woven by the Moros of Cagayan. The Palawanos of the south weave a petate of bejuco of the best quality, split in two and one side painted black. This weaving is known among them as biday among the Cuyonos and Tagalos as biray. This petate is valued among the Filipinos and is used in some places as a carpet, and among the Tagbanuas serves as a bed. The value of the petate varies according to its size and the quality of the bejuco. If it is bejuco of the first class, known as seca, each petate whose width is a meter will cost from fifty to sixty centavos; if it is of second class quality, known as bugtong, its price will be forty centavos.

The principal occupation of the men is to till the soil for the planting of palay, corn, camotes, plantain, and other tuberous rooted plants; to cut bejuco of different kinds especially that known as seca and which is much valued; to bring from the mountains almaciga, bees and wax, etc. All these articles are carried to the villages and sold at a very low price to the merchants who usually are Chinamen. But this is not the usual custom, for the Tagbanuas are very timid and seldom attempt to go to the villages and commercial centers to sell their effects. For this reason the trading is done by roving Christians and Moros of the south who exchange

with them cloth, ornaments, etc., and in times of scarcity, rice at a price more or less dear. The Moros are more than usurers and oppressors in their trading transactions with the unfortunate Tagbanuas who are easily deceived. In order to realize a lucrative trade and to be assured of fabulous gains, the Moros begin to invite the friendship of the headmen and local chiefs of the rancherias, feigning sympathy and intimacy, bestowing upon them the title of sandugo, or brother in blood. In the majority of cases they will presently give to them a certain number of pieces of cloth, bolos to work the soil, cooking utensils, dishes, etc., in order that each chief may distribute them among his people, very seldom speaking aught of the price. When all these things have been distributed, they will demand for their payment wax, almaciga, bejucos and palay if it is the time of harvest. These things are demanded in large quantities and at an insignificant price. Besides this they will cheat the miserable Tagbanuas in their weights and measures which are generally very large. Even today if we desire proofs, we shall find in the southern part of the island weights which the Moros and Tagbanuas use in their transactions. They are so large that a pico of almaciga or wax on their scales would give them 250 pounds instead of 137½ pounds, which is the legal pico; and their gantas are so large that a cavan measured according to our standard would contain 31 or more gantas. This inequality of weights and measures on the same island to the detriment of the unfortunate Tagbanuas, merits especial attention and requires effective remedy on the part of the persons called by the law to regulate them. I lament that this is the case not only in the south, but it occurs in almost all of the towns and barrios of the island where the corruption of weights and measures in general is found in a greater or less degree. In this part, the weights are not so much marred as the measures, which are usually made of caña espina known as alupañ or gantangan (ganta) and of the interior husk of the cocoanut known as pulacan (chupa) instead of making them of wood according to a fixed standard. The size of the pulacan varies. Some are large and of various denominations; such as the apatan equal to four chupas, lima-an, aneman, pitoan, and waloan, the last equal to our chupa which was a diminutive measure equivalent to an eighth part of a ganta.

As I have said before, the Moro will give to the local headman a certain number of articles for which he demands bejuco, almaciga, wax, palay, etc. If the debtor, a headman, is not able to pay the

sum required upon this occasion his creditor will designate a time, usually a month, in which time he will return in person or send a representative to collect the debt, with this provision that in case the fixed time should have expired and the debtor is not able to pay then shall the amount be increased two fold. When the day has arrived and the debtor is not able to settle, the creditor will again fix a time and thus successively until the debt is finally paid. If in some of the visits of the creditor or his representative, he should be able to obtain some almaciga, wax, objects of metal, etc., whose amount would not cover the debt, not even the half, these objects would not be placed to the credit of the debtor but would only serve as a fine or the payment of the expenses of the voyage of the creditor in his going to and from the rancheria of the debtor. In case the days of grace have expired, and the debtor, notwithstanding his superhuman efforts, does not find possible means to liquidate the debt, then the creditor will declare him and his posterity slaves unless his fellow beings aid him to pay. In this case, the creditor can not refuse to accept the sum which they, for the sake of humanity, delivered. If the debtor be a headman or chief, he will not, because of his position and dignity, fall into slavery; but he is obliged to redeem himself by one or two of his own slaves according to mutual consent and the importance of the debt. The delivery of the slaves being made, this vexatious business is terminated and the creditor will return to his rancheria with the slaves thus obtained. The nobles or headmen for whom the slaves have been given are irresponsible for their escape. Should the slaves return to the homes from which they were taken, the creditor has the right to demand them at the hands of the local authorities who are obliged to send them back. In consequence of this irresponsibility the slave capturers are oftentimes deceived by the slaves who after being with them a few days manage to escape, hiding in some situation unknown and ignored by the slave owners. But there is no evil in this world, with the exception of death, that has no corresponding remedy, more or less efficacious, so the slave capturers, in order to prevent this escape which occurs so frequently, adopt very rigorous measures, keeping their slaves well guarded until they have the opportunity to give them to strangers in exchange for articles of commerce at a price more or less cheap. These strangers usually are the Moros from Cagayan de Joló who annually visited Palawan and with whom the Moro chiefs of these islands engaged in the slave trade. Many slaves, Tagbanuas and

Palawanos of both sexes, were taken to Cagayan de Joló until the years 1899–1900, a time of misrule for the island in whose southern part the Moro dignitaries were owners of life and lands especially the obstinate and rebellious Salip Yasen of Culasian, afterwards taken to Alphonso XIII where he died. He was a powerful and warlike chief and recognized neither the Sultan Bataraza nor the Filipino Governor of the island. Finally he declared war against his own chief during the latter part of 1900, but without results. If I am not wrongly informed I think the incentive which provoked the hostility between these two Moro dignitaries, was the outcome of a slave trade.

Tagbanuas known as Palawanos

After the Apurahuanos who, as has been said before, are the most numerous, follow the Palawanos, a tribe inhabiting the southern part of Palawan and which name they have taken. They occupy the east and west coast, embracing the rancherias of Tigman, Calategas, Punta Separacion, Aramaysan, Paniquian, Tagasao, Lada, Ipolot, crossing the rancheria of Bono-bono celebrated as the official residence of the Sultan Bataraza; around the point of Bulilian crossing to the rancheria of Culasian also known as the chosen residence of Bataraza and in the interior of which lived the troublesome Datto Tumay. Here occurred the fight in March, 1904, under the command of our Governor, Captain Miller, to recover the 31 guns and some revolvers which had been stolen by the Moros from the 48th Company of Scouts in an expedition for geographical purposes. From this place the Palawanos inhabit the rancherias of Ira-an and Tagbuaya. From hence are the rancherias of Quinlugan, Paniquian, Alphonso XII, Malined, Buyata, Tumarbong, Ihuahig, Isugud and Aramayoan—all the rancherias on the western coast being occupied by Palawanes and Moros. The Tagbanuas Palawanos, properly speaking, differ from the Apurahuanos only in dialect, in some of their minor customs, and in the manner of eating; otherwise, these two tribes are almost identical save in the use of writing. This tribe has no mark or known characters, for this reason they have adopted the Arabic and Tagbanua characters. The Islamites use the Arabic character; those influenced by the Apurahuanos use their characters.

The Civil Hierarchy of the Palawanos

Datto, Moro authority, a kind of Governor of the district, which embraces a certain number of rancherias.

The panlima is the chief of a rancheria.

The maradia is next to the panlima.

The orangcaya, sattia, and tumangong, are councilors of a rancheria.

The seat of government is in the town. The administration of justice is in the hand of the tribunal, which is composed of the panlima and the dignitaries above mentioned. Though in case of a slight fault which may not be considered among them as a crime, each chief is able to pronounce judgment, the sentence of which is usually respected by all. In case of an appeal, it must be taken to the tribunal where resides the datto who governs the rancheria. If, notwithstanding his decision, the parties are not yet satisfied, which is very seldom, they can go to the sultan of Bono-bono, where presides the supreme tribunal of the Moros and Palawanos. Against the sentence of the sultan there is no further recourse, unless this ruler, in the light of circumstances, should take this to be a penal crime; in which case the accused is sent to the superior authority of the island with the previous and detailed account of the act, to which justice shall be done. This occurred during the Spanish dominion at which time Muhamad Alon Narrasib (of grateful memory) governed the southern part of Palawan inhabited by the Moros and Tagbanuas Palawanos. Because of his faithfulness and loyalty to the established government he became the worthy and celebrated sultan of Jolo, afterwards of Bono-bono. He was the father of Datto Bataraza above mentioned.

The Crimes of the Palawanos and their Punishment

As I have said before, the two tribes differ only in their dialect and in some customs. The punishment which is imposed upon those guilty of crime and minor offenses is exactly the same as those of the Apurahuanos with the exception of those of adultery and murder. The family of the murdered demand an indemnity, which varies according to the social position of the one who was killed. If he belonged to the rich class the murderer has to pay to the family of the dead man 100 pesos; if he was poor 40 pesos is sufficient. Among the Palawanos there is not tolerated the abduction of a married woman as is the case among the Apurahuanos. The crime of adultery is not only held by them as a dishonest and scandalous vice, but is punished very severely. And not only has the offended husband the right to kill, but whatever relative should thus surprise them. For this reason, among the women of the

Palawanos is found more faithfulness than in the other tribes. The customs among the Palawanos themselves vary. The inhabitants of the rancherias where the Moros reside and from whom they receive their influence follow and adopt the customs and usages of the Moros, thus eating no pork and receiving the Moro baptism known as Islam; while those inhabiting the interior and the mountains adopt the customs of the Tagbanuas with a slight difference. The Palawanos pay a kind of tribute to the family of the ruling datto at Bono-bono, which usually consists of rice, wax, etc., in quantities determined by the ruling datto and the respective dattos of the rancheria.

This tribe knows only two gods, whose names are the same as those of the Apurahuanos. Their ideas of the life after death are also the same. The little bird, saguay-saguay, the messenger of Diwata, is known to them as sapued. The singing of this bird, the peculiar sound of the lizard, and the sneezing of a person have the same significance.

The Palawanos who are Islamites and who live in the southern part of the rancherias inhabited by Moros, being influenced by these, observe the fiestas of the Moros; while those living in the interior observe those of the Apurahuanos. But they always observe two days in common, the first and fifteenth of the moon. There is only one annual fiesta which they hold with much solemnity and which is known as Ronsay. This celebration takes place on the beach or some other spot made known beforehand. It is observed one or two days before the soil is broken for the seed, which usually occurs in December. The object of this fiesta is to thank Diwata for the good harvest and the favors received during the now ending year; and to ask him to give to them his protection and favors during the coming year. The observance is the same as that of the Apurahuanos, save that among the Palawanos it is permitted to take part in all the games and the dances.

The Islamite Palawanos have their children baptized by the Moro priest who is known as Imam. Those who dwell in the mountains observe the same ceremonies as the Apurahuanos.

Those who are not influenced by the Moros are almost identical in their manners and customs of the Apurahuanos. Their manner of receiving strangers and persons of importance is very much the same, with this slight difference, that in courtesy they are somewhat rude and gruff, and they lack in hospitality.

The Palawanos of the extreme south are very unsociable and not communicative with strangers, owing no doubt to their peculiar

dialect. These Palawanos feed upon wild animals, vermin of the forest, worms and grasses, centipedes, snakes, monkeys, etc.

When any of these become ill the babailan cures them. Should a person die whose infirmity the babailan could not cure, the cause is attributed to witchcraft. The body of the dead is bathed and then wound from head to foot with one or more pieces of white cloth. If the deceased was rich, his body will be placed in a coffin; if poor, in a basket of caña espino very similar to a chicken coop. There is no ceremony observed at the grave, save that articles of food are taken there and upon it are placed the various articles of more or less value which had belonged to the man in life.

The Islamite Palawanos observe the sambayang of the Moros, which corresponds with our novenary. If the man was rich, during this period of vigil large gifts are distributed consisting of money or cloths, according to the pecuniary ability of the family. This gift is obligatory on their part and thus if any child or relative of a moderately rich Palawano dies, these compulsory expenses very often reduce him to poverty.

The riches of the Palawanos consist in metal dishes, rice, money, servants, and slaves.

Although the Islamite Palawanos are on good terms with the Moros, this is not the case with the Palawanos of the interior and the mountains. Between these and the Moros there is constant warfare. No Moro, alone, is able to penetrate the woods or to cross the line which separates the rancheria from the territory occupied by the mountaineers, without danger of being killed. This is done to avenge the disappearance of their countrymen who had fallen victims to the excessive oppression of the Moros and who were either killed or were made slaves, being taken away to distant places and there sold. The mountain Palawanos, for the same reason, never crossed into the territories of the Moros.

I have already spoken of the industry of the non-Christian tribes including the Palawanos. But the Palawanos of the coast, notwithstanding the timidity of their character, are the only ones who come here after the harvest to sell their products of rice and petates of pandan and bejuco known as viray. They are always accompanied by certain Moro friends. I have known no other kind of commerce among this people and I have never seen one Moro who worked the soil in order to plant the seeds, not even a camote or plantain, much less palay. The exception to this were two brothers, who had lived with Christians ten years and who in the time of the Spaniards had been held as prisoners.

The arms of the Palawanos are the kris and some of those who live along the beach possess guns. Those who dwell in the mountains use the blow-gun, which is a hollow bamboo joint about two meters in length. The darts which are used are small sticks in the form of quills made of cane, the point of which is poisoned with a substance which they make, in color like pitch. The activity of the poison is so terrible that a man or animal wounded by the dart will die within ten minutes. The unfortunate being scarcely moving two or three paces will fall to the earth, his vision fades, he will vomit severely, consciousness leaves him, and amid cold perspiration he will expire without uttering a word. Upon one occasion I found myself in the territory of the Batacs in the barrio of Caruray and there witnessed a case of poisoning of this nature. It was the result of play. One of the men of the tribe who was very skilled in the management of the blow-gun had one brought to him. Without examining it in the least to see whether it contained a dart, he blew into it with all the force of his lungs. But behold, the jest proved dear, for without more ado there came out of the mouth of the blow-gun a dart which penetrated the calf of a leg, causing the person to fall immediately to the ground. As soon as the one who handled the blow-gun saw the magnitude of the misfortune he hastened to the man and took out the dart. He then fell upon his knees and began to suck the wound, so that the poison should not reach the heart; at the same time an old man hastened to the woods to procure a certain kind of medicine. Having drawn out sufficient of the blood, whose color appeared black, and in the meanwhile the old man having not yet returned, they applied to the wound a poultice whose principal ingredient was lemon, causing the wounded man to partake of it. They assured me this remedy to be sufficient to counteract the poison; but that the medicine which the old man sought is more effective. He returned with roots of trees which were unknown to me. These he applied to the wound and shortly afterwards the unfortunate man revived and was as well as ever. In my dealings with the Batacs I have handled this weapon against wild beasts and I am convinced from my own experience that this poison is more fatal to animals than to man, for a lizard being wounded died immediately in the midst of terrible convulsions. A monkey fared the same. This inoffensive animal was hanging to a branch of a tree when it was wounded, but immediately fell and was dead when it reached the earth. The animals killed in this way are not

flung away. The poison does not hinder their being eaten by the Batacs and mountaineer Palawanos, who with a knife or bolo cut away from the body the part injured by the dart.

Weights and Measures used by the Palawanos and Apurahuanos

The steelyard consists of a piece of wood the size of a cane about three feet in length, some being longer, others shorter. This is suspended from a string which is fastened a fourth of the distance from the end of the yard.

The rod is marked with points and lines which indicate the weight. The points indicate the half cate and the long strokes the cate. This weight, which is known among them as timbangan or chinantanan, is provided with a counterweight of stone, iron, or lead the same as ours. Each cate weighs ten pounds. Ten cates are equivalent to a chinantan and two chinantans are equivalent to a pico, which is equivalent to 200 libras according to our weight. The timbangan is used to measure the almaciga and the bejuco. This scale varies in size. The smaller one is used very frequently to measure the beeswax, and this unit of weight is equivalent to five pounds and sometimes seven.

A cavan contains twenty-five gantas which gantas are much larger than ours. In place of a bag they use the bayong, which is similar to petate. The liquid measures are the tabo a cup made out of cocoanut shell, the gori and the bottle. The bottle is used to measure the honey which they sell to the Christians. In times of scarcity a bottle is worth twenty centavos.

For unbroken land which is to be sold for planting the unit of measure is the braza de bolo, whose operation is as follows: A man places himself in a standing position. On his right hand is hanging a bolo; in his left hand is a caña bojo, whose end touches the earth at his extreme left. The right hand being raised until the bolo is in a vertical position, marks the distance where the point of the bolo touches the caña bojo. A piece of land 20 "brazas de bolo" square is equivalent among the Palawanos to ten gantas of palay, payable in advance. Another method of buying land is to pay four cavans of palay for land which has been broken and prepared and which may contain 30 gantas of seed, the Tagbanua ganta being larger than ours. This is the account of the purchaser for all the expenses incurred, including the work from the planting of seed until the harvest.

These people do not know the meter, the yard, nor any other measures. They are equally as ignorant of chronological measurement. No one knows his age nor can tell the time or year in which he was born. The only mark of time they know is the month Bulan, which they reckon from the first night of the new moon, or "Lati" until the last phase of the moon. They calculate the ages of their children by the harvests which annually occur in some other place. For this reason if we should ask a father the age of his son, he would begin to count from the time when a certain seed planting took place when his child had been born. Should the child be more than ten years of age the computation would be impossible to make exactly; for these people have no list of their consecutive harvests. And thus the only answer is that they are not accustomed to count the years.

The Queneys

There is another tribe in the south, dwelling in the mountains of Lad-da, Ipulot, Buligay, and near Bono-bono. They also inhabit the mountains of Culasian on the opposite coast. They are known by the Palawanos as Queney, but of them little information is available, acquired from Palawanos and Apurahuanos. According to them this tribe differs much from them in custom and dialect. They do not like to trade with any of the tribes, being afraid of catarrh. Should any one of them become afflicted with this sickness they are sent away to solitary places. They live apart in the mountains. They form neither rancheria nor settlements. They have no chief. Their government is patriarchal. They build no houses, living in rude huts and the trunks of large trees. They clothe themselves with the bark of the antipolo tree similar to the Batacs. They eat vermin and wild beasts, the most favored being the "pantut." They are very warlike and arrogant. Although they have no chief of their own, there are some who, having received the influence of the mountain Palawanos with whom they trade with much distrust, recognize the authority of the panlima, but with much indifference, though they accept his commands. Some of the trading Palawanos have ventured with merchandise, bolos, hatchets, cooking vessels, etc., to enter the mountains inhabited by the Queneys. Never do they permit traders to approach their dwelling places, keeping them at quite a distance. The head of the family will make a sanitary inspection of the traders and if they have no catarrh they may approach. This inspection is done at a safe distance so that

the voices are heard by all. The chief will then ask them what they desire in these parts, to which they reply that they have come with merchandise with the object of selling it. This news the chief bears to his family, who, being hidden, make known what they want, and the chief will return to the trading place. If the old man and his family have no mistrust, they will invite the traders to come forward; if, however, they are mistrustful, the transaction takes place in the original place in the following manner. The trading is done in a loud voice and at quite a distance. The head of the family will name the articles he needs and requests that they be placed in a designated spot. He will then go there and take away the articles replacing them with almaciga, beeswax and bejuco in quantities according to their mode of thinking; for they have no weights neither do they understand such operations. As can be imagined the traders have the best of the bargain. Being genuine mountain people, very few of them know the coasts of the sea, to which they come only to procure the salt. And even then they select a spot unfrequented by people. It is said by persons who have had occasion to observe this tribe that when the day arrives to go to the shore for water from which to procure salt, this being done annually, they first of all like thirsty beasts, drink to satiety, because in their homes salt is treasured as we value gold and for this reason is the most important article of trade between the Queneys and the Palawanos. This tribe is more cruel than the mountain Palawanos. They are most inhospitable, suspicious, and distrustful in the fullest meaning of the word. They are exceedingly dirty. They are charred from their breech cloths to the face, by their constant lying during the night close to the fire, and the dirt serves as a mantle to protect them from the cold and humidity. The greater part of the tribe inhabits the caves of the mountain.

Because of the nomadic condition of this tribe and the difficulty of acquiring exact information, little is known of their form of government, save that it is patriarchal. The information given by the Palawanos who have met the Queneys at close range, is more or less truthful, and according to their opinion, it is not venturesome to say that the Queneys not only have no idea of government, but that neither do they have a system of administering justice similar to that of the Tagbanuas and Palawanos. In the same manner we believe that the Queneys have no idea of Diwata nor of a life beyond the grave; for we have no knowledge that they practice any of the religious rites known to the Apurahuanos and Palawanos.

The Queneys are of normal stature and delicate in appearance. Their hair is black and kinky like that of the Batacs. They traverse the dense woods easily and their foot-steps leave no trail. Never are they seen first. They always are first to notice those who enter their woods, especially if they be strangers whom they watch in ambush, hiding themselves in the trunks of large trees. Seeing the strangers at a great distance, they are at once ready to surprise them with the blow-gun. Calling out in a mournful and fearful voice they ask the following questions:

"Who are you?" "Whence do you come?" "What is your name?" "What has brought you hither?" etc., ending with the important question: "Have you catarrh or any other sickness?" The people being thus questioned answer them, telling their names, their objects, and whether or no they have catarrh or any contagious disease. In the latter case they are immediately expelled from those parts, and are told with warning that in the future they should refrain from making another visit.

We know nothing of their labor save that they cut the bejuco and gather the almaciga and beeswax to exchange for cooking untensils, bolos, etc. They cultivate the soil for their seed planting to such a limited extent that its products scarcely supply their necessities even during the first few days of the harvest. They also plant very few tubers.

The Queneys use no arms save the blow-gun, in which use they are very skilled. It was from them that the Palawanos learned to use this weapon; and according to the Palawanos it is the Queneys who make the poisonous substance with which they cover the ends of the darts. This is all the present knowledge we have of this nomadic tribe and of their conditions and territory which has been little explored even by their friends the Palawanos.

The Batacs

There is another tribe which occupies the mountains of north Luzon known as the "Batacs." This tribe lives in the mountains of Babuyan, Tarabanan, Langugan, Caruray, Quinaratan, Buhayan and a small part of the barrio of Barbacan; on the west coast they live in the mountains of Caruray.

The Batacs are usually smaller than the other Filipinos. They are well formed and agile. The nose is generally of better shape. The hair is crisp and curly, less black and less ugly than the negroes of the African coast. The Batacs inhabit the interior almost reach-

ing to the high mountains where begin their rice fields, so small that the products thereof furnish scarcely enough food during the first days of the harvest. They cover their loins with the bark of the antipolo, namuan and inbalud. This garment known as bahag is made into different forms, some being painted red and yellow. During the time of harvest, they live on rice; in the time of scarcity they eat roots, the fruits of the forest, wild boar, squirrel, and vermin. Their chosen delicacy is wild honey and a preparation made of this and the larvæ of the bees, boiled like rice. They hunt the wild boar and birds by means of the arrow and the blow-gun, which they handle with almost incredible skill and accuracy. They are always followed by their wives who with hair unbound, very curly and disarranged, carry their children suspended from their necks in a cloth made of the bark of trees and with the four corners tied together. This weight rests upon the back or is sustained at the breast. Apart from this, they carry small baskets made of woven cane and which contain the articles needed for the journey. The men bear naught but the bow and arrow, the blow-gun, a lance if there are any, and a tube made of cane. This is suspended from the waist by a piece of bamboo or string. Within the tube or ranque are steel, flint, and fuse; the fuse being the shavings of bamboo and the beaten bark of palm. With this apparatus they make fire which they call santican.

Twenty-five or thirty years ago the Batacs were nomads. They formed no rancherias and slept wherever night overtook them. Today, thanks to their frequent trading with the Christian and semi-civilized Tagbanuas, their savageness has not only moderated but has practically disappeared. Now they have commercial relations with strangers and admit them with hospitality and confidence. Among this number they chose one who inspired them with confidence and gave them more protection. The Batacs gave to him the title of agalen, which means friend. He it is who provides all they need, such as bolos, cooking utensils, etc., including rice in times of scarcity; in exchange for these articles bringing to him almaciga, bejuco and wax. The Batacs differ slightly from the Queneys. They eat the same kinds of food with the exception of worms, centipedes, lizards, etc. With the exception of the Batacs known as Buhayane, who inhabit the mountains about Malcampo and Umalad, they do not eat snakes and inguanas. The Buhayanes are very warlike and cruel towards their enemies as demonstrated during the Jolo piracy which reigned in this island.

Their daring is well nigh incredible. If any one of their number should encounter in a cave or in the hollow of a large tree a large snake known as biay he will notify his companions and ten or more of these will hasten to the place. One of them with a loop made of bejuco will enter the lair of the reptile in order to bind him. Presently by the force of the throw they will cause the snake to come forth. If in spite of this operation it will not come forth, then they will make a fire. When the reptile appears he is cut into pieces and each person receives the part which he has touched.

The Batacs are very dirty and strangers to the bath. Their bodies exhale a fearful odor. Their skin is very much charred owing to the fact that they constantly lie near the fire, which protects them from the cold. They live in small huts made of palms. They form no rancherias like the Tagbanuas, but dwell in families in the mountains and the interior of the woods. The women give birth without any aid. When the appointed time has come the husband constructs a small hut, and the woman is placed therein in a horizontal position. A piece of wood is her pillow and a petate is placed under her body extending from the head to the waist. After the child is born the woman will arise without being aided. Having taken her medicines, which consist of certain roots, and leaving the child unbandaged and uncovered, she will go to the nearest river and bathe. She will return with a vessel of water and bathe the newly born child, and is now ready to do all kinds of work including the hulling of rice. After the birth of the child, the mother always has a vessel containing water with which she bathes the child whenever it cries, emptying the contents upon the head of the child until its crying ceases. This manner of birth and care of the child is also observed among the Apurahuanos.

The children are baptized by the fathers without ceremony, some immediately after being born, others after a period of two years or more, according to the desire of the parents. Their names usually are those of animals, trees, rivers, places or spots in which they were born; and not infrequently they bear the names of Christians, such as some of the Batacs of Caruray known as Elicon, Lorenso, Victorio, etc., owing no doubt to Christian influence. If a child has been born near a certain river it will bear the name of that river.

When a young man desires to take a wife he will ask permission of his father. This request being granted, he will take espousal gifts consisting of bracelets and rings of yellow metal, turtle, and carabao horn to the house of his intended bride and give them to her

parents, who receive them with much gratification. The future husband may or may not be accompanied by his friends. He will remain at the house of his sweetheart for a few hours. This now signifies that he has claims to the girl. The father will then signify a day when the young man may formally ask for her hand, and the day having arrived the families will meet in her house and decide upon the time of marriage, which usually takes place two or three days afterwards. The marriage ceremony of the Batacs is the same as that of the Apurahuanos. After the completion of the ceremony the families and invited guests enjoy the feast which consists of drinking pangasi and eating wild boar, monkey, etc. They do not care for the dance. When partly drunk they enjoy singing the tud-tud or dagoy, which the Apurahuanos also know. There are some mountain Batacs who dance the "talutad." A man dances this very rapidly and to the sound of the drum. The song of the tud-tud is a tale of the ancient deeds and history of certain men and women who were much honored. It also may be the story of dear ones who have died.

Polygamy is permitted to both sexes. During the six years that I lived in Caruray at a place near the Batacs, divorce and the abduction of a woman were rarely known.

The most common diseases among them are skin eruptions, such as itch and tetter, tumors, and malarial fever and catarrh. This last is the most dreaded and common disease among them owing to the rough weather and to the heat. The tumorous affection is the most dangerous and causes much loss; yet they take scarcely any care because of it, although it is contagious. The children who fortunately have not been attacked by this disease are inoculated with it by their parents who according to their mode of reasoning, think it better to be thus afflicted while young; for to be touched by it in old age causes the person to suffer more intensely. For this reason 60 per cent. or more of the people are afflicted by this disease. The Batacs of the mountains have no experience whatever and they never take into consideration the terrible effects of this sickness which decimates them and makes them useless. For the persons so afflicted, not only lose their physical strength, but in the majority of cases become utterly helpless. Their joints become weak, and after a little while ulcers appear. I have known various Batacs afflicted with this evil. Their aspect was thin and nauseating. Afterwards in spite of the spreading of the wounds which broke forth on all parts of the body, especially in the lips, and

which caused the man thus afflicted to be more hideous than Dante's Demon, these sores disappeared without the use of medicine. The scars remained. Those who have this disease can easily be recognized by the black scars about the mouth which very frequently have caused the natural size to become smaller. The joints of the fingers and knees remain swollen and the limbs weak.

The diseases which cause horror and fear are the measles and small-pox. Whenever these contagious diseases invade their homes they flee to the mountains, each family or barangay living by itself. Neither will they return until the epidemic has completely disappeared. It would be very dangerous for any person to encounter them during this period of roving. During this time they communicate with no one neither do they any kind of work but hunt wild animals, fruits and bees for their daily food. This tribe can suffer hunger for a long time. In time of scarcity they are accustomed to go without food for a day or more and consequently they are very thin and weak. On the other hand, during the harvest they eat day and night, resting but for a short interval. They always have on hand a large quantity of boiled rice prepared by the women and they eat whenever hunger demands. To prepare the soil for the planting of rice and to cut the large trees is the work of the men. The women sow and gather the harvest, hull the rice and do all the work pertaining to the house.

Although the Batacs of the west at Caruray do not dance, those of the east dance the sarunkay, a very slow movement executed by a man to the sound of the sabagan, the agun, babandel and guimbal. The agun is a piece of soft wood with the bark taken off. It is ten feet in length, more or less, and twenty-five or thirty centimeters in circumference. This wood known as li-it hangs in any part of the house, being held by cords fastened at both ends. The instrument is played by a woman by means of small pieces of wood shaped like drumsticks. Their other dances are the same as those of the Apurahuanos. The women do not take part in any of these dances, it is their part to play the instruments. At the feast of sangbay men and women dance.

The Batacs of the mountains recognize the same gods as the Apurahuanos. It is the duty of Diwata to provide for men and to reward them according to their good deeds. Angogro dwells in Basad, at the entrance of which is an iron bar and which the souls must pass. Whether a soul is destined to die or not is known by the ascending or descending of the bar known as "bari-bari." When

a soul presents itself at the entrance of Basad, there is found at the door the god Angogro, who, when his eyes are open, is asleep and when his eyes are closed is awake. The soul about to enter will receive freedom and is permitted to return to earth, if the bar obstructs the entrance; on the contrary if the bar ascends, it signifies that all hope to return to life has perished. The soul that enters Basad is examined by Angogro regarding the life he led upon earth. He is warned to tell the truth; for before him Angogro it is in vain to lie, since naught is hidden from him. The soul thus summoned to the judgment, will begin to extol his virtues and good works and end by telling his evil deeds. The examination being ended the soul is sent to Diwata who decides the case. If the result is good the soul enters Lampanag, a beautiful abode; if on the contrary the soul is guilty he is thrust into the depths of Basal where in large caldrons are fire and boiling water.

The Batacs of Caruray also have certain other saints. Siabuanan is a saint who is a demi-god. It is his duty to aid Angogro to receive the souls and to make known to him whether the soul being a male, had known how to cut trees, how to handle the bow and the blow-gun with skill and accuracy and whether he fulfilled his duties with honor. If the answer be yes, then the soul is permitted to present himself before Diwata unharmed; if, on the contrary, the answer be no, then Siabuanan punishes him, hitting his fingers with a small hammer with which he is armed. The soul that had been a woman is also questioned concerning her private life and the ordinary duties pertaining to her sex, such as the weaving of petates, tampipes of caña bojo, the small baskets for tobacco or buyo, the making of cloth of the bark of trees, etc., and finally their hands are examined in order to note the calloused spots. If the examination be favorable the soul enters Lampanag; if, on the contrary, their lives have been lazy and their hands are not calloused, then they are also punished by Siabuanan.

The other saints are Bancacalo, Paraen, and Buenguelen (the last two are married) and Baybayanen. These saints are of great strength. Their deeds of valor are innumerable. In remote times when piracy reigned all over the island, the people were saved on many occasions from capture and slavery. Because of this, terror possessed the minds of the Moro pirates, a feeling which still continues among them; for no Moro ventures to attack the mountain Batacs, especially the Tandolanos of whom we will speak later.

This tribe celebrates no fiestas with the exception of that of

sangbay, the same as is observed by the Apurahuanos. This takes place in April. The celebration of the fiesta is the same as by the Apurahuanos with the difference that all classes of diversions and dancing are permitted and in them men, women, and children participate. Neither do they observe the sacrifice of the chicken as the Apurahuanos do. The Batacs, however, construct two little huts in imitation of a house. In the one house is placed palay, in the other are imitation houses of bees made of the leaves of the balasbas or species of palm. The babailan will then recite the prayers and earnestly beseech Diwata that he give to the tribe a year of much palay and bees. The two little houses signify that in this year Diwata give them an abundance of palay that shall fill their houses and that the woods be filled with bees. The ceremonies being completed, they will eat, drink, and dance. They eat heartily very much like beasts. The celebration of this feast takes place in the solitary places of the woods, distant from the beach two or three kilometers.

When one of the people becomes ill the babailan officiates in the same manner as among the Apurahuanos. When a quarantine is established, instead of placing mecate, or ropes at the entrances to the house, a piece of wood known as langaday or gaalo an instrument used to hull rice, is placed there. When a man dies, especially if it be the chief of the tribe, the news is told to all the people. Every one is obliged to break forth into weeping even including visiting strangers. When the head of a family or some person of distinction dies special messengers are sent to all the places. When the messengers arrive, they do not speak, but they take the hand of the head of the family and either kiss it or press it. The family then know the dire misfortune and accompany the messenger to his home. Surrounding the body of the dead person, they weep, speaking amid their lamentations of the dead man's powers, his influence among the tribe, his meritorious deeds, etc., which custom, among us, would augment the grief of a family instead of allaying it. The body of the dead is permitted to remain in the house for an indefinite time, according to the wish of the family and the social position of the man. The body is buried without any ceremony. In the grave are placed articles of clothing and food and this act is repeated from time to time.

Moreover there is another custom which is very peculiar and equally ridiculous. Three days after the burial of the body, every person who assisted at the interment is obliged to return to the

grave and place upon it a stone in order that, according to their belief, the soul may be able to enter Lampanag. Should this practice be neglected it would prevent the soul from entering paradise and oblige him to wander about in the lonely places of the forests and mountains.

The Batacs lack the government of the tribes of the south. The settlement is governed by a capitan who is chosen either by the chief of the province or by the local chiefs of the barrios. The form of government is really patriarchal. The authority is in the hands of an old man, chosen because of his superior merits and who, together with the old men of the tribe, dispenses justice according to their laws and customs. The decisions thus granted are received with much humility.

Murder is punished with death, if the murderer is not able to pay the family of the murdered one a certain quantity of bandi determined by a tribunal of the old men, the quantity being equivalent to ten or fifteen pesos. This being paid, the business is settled.

The family of the murdered has the right to avenge itself by killing the assassin, provided, however, that the news of the deed has not yet been made known to the old men.

Robbery or theft of whatever kind is punished by means of the lash, provided that the guilt of the person is proved, though should the thief be caught in the very act, the owner has the right to kill him.

The crime of adultery or the abduction of a married woman is considered very grave and is punishable with a heavy fine. Should the husband surprise the guilty ones he has the right to kill them.

A man is considered rich if he has sufficient rice to supply his needs for one year, if he has a large number of vessels and plates, bracelets of metal and shell, and much clothing.

The Batacs of the mountains engage neither in agriculture nor in commerce. They show no kind of interest or love for planting palay which is their principal food; neither do they care to plant the tubers which are a substitute for rice in times of scarcity. For this reason there is much misery when there is no harvest. Scarcely one family among them will plant in their badly prepared soil 6 gantas of palay, and seed fields are very rare that contain 25 gantas of seed. It is only the chiefs who possess these and this is due to the fact that all their subjects are obliged to help them to break the soil, to plant, and to harvest. Among the Batacs exists

the custom of helping one another in planting and gathering. The first one among them whose harvest is ready is obliged to notify the others. They will come with their respective families to assist at the harvest, each one taking to his own dwelling that which he has been able to cut. This generous custom very often causes the owner of the small harvest to have little palay left for himself, though of course there remains to him the right to aid others in their harvests, that portion being his which he and his family cut. During the harvest time there is no work done but to gather, hull, and boil the rice, which is all done by the women. As has been said, there is always on hand a large quantity of boiled rice which is eaten at any time and chiefly by the men who at this time are found lying in their houses day after day and only rise to eat or to go to the hunt.

These people are skilled in the hunt of wild boar. They use various kinds of traps. The garet is somewhat like a small house twelve or more feet in height and is placed in the top of a tree which yields a fruit pleasing to the wild boars. There enter into this house one or two men with bows and arrows who await the approach of the boars which usually come in numbers. Upon the arrival of the animals the two men discharge their arrows, and if the shots be accurate, the animal will either die almost immediately or it may be able to run a short distance, but this happens very seldom. The most interesting and peculiar way among them in hunting the wild boar and perhaps the most certain and complete method is the following:

All the people of the settlement, including women and children, will go to a place known by them to be the trail of the boar. This place is usually some point of mountainous land lying along the sea. Certain men who are skilled in shooting the arrow take a position well selected, where in all probability the animals will pass. The women and children and unoccupied men will spread about in the woods, breaking forth into terrible shrieks, some howling and others barking like dogs. These shouts and noises bewilder the boars, which hasten towards the positions taken by the shooters who await them with bow and arrow. Very often they escape the darts and jump into the sea. But two bancas having previously been prepared and manned, the poor animals cannot escape that way. This hunt usually continues for a day and even longer. Afterwards they return to their houses with the spoil. Almost in the very completion of the hunt they begin to eat the flesh. This manner of hunting is known as sagbay.

After the harvest there is a period of almost complete inaction. They go about from place to place as the spirit moves them either along the sea to fish or to the mountains to gather whatever they may desire.

The Batacs of the plains weave the small baskets known as baay, but never in quantities sufficient even for their own use.

They do not weave the beautiful petates which the Apurahuanos and Palawanos make. They are people who are very dirty, uncivilized and enemies to any kind of toil. They never work unless they are hungry. They eat like beasts, each man being able to hold as much as two able-bodied men of our kind; a fact which I found out upon different occasions when I employed Batacs to work the soil and plant the palay during the six years I lived in Caruray. After having eaten they want to lie down, for they do not like to work when they are filled or satisfied.

The Batacs trade with the Christians and Tagbanuas. They bring from the mountains almaciga, bejuco, and beeswax in exchange for bolos, cooking utensils, etc., which are always paid for in advance. They are so very lazy that never do they fully pay, with the products brought from the interior, for the articles which were advanced to them by the trader. Consequently they are always involved in debt. The debtor is converted into a sort of slave. Thus he is obliged to go to the mountains to gather the products thereof, whenever his creditor desires him to do so.

They have no weights and measures of their own invention; the gantas and weights which they use are those of the Christians. Very seldom do they use the chinantanan of the Apurahuanos and Palawanos. The measure of the arm and palm, of course, is in constant use.

The arms of the Batacs are the bow and arrow, the blow-gun, and the lance. The use no guns, krises, or bolos. The darts and arrows are made of the palma brava. Their form is that of a harpoon. This arrow is used only against their enemies.

There are three kinds of musical instruments which this tribe use that merit special mention.

The codiape is a sort of guitar, six or more feet in length. It has only two cords of the fiber of the olango or bancuang. The form of this instrument varies. Some are very large and shaped like the head of an alligator. It is played either by man or woman while the other sings the song known as avellano.

The budlong is a joint of caña espino with a hole in its center

like that of a guitar. It has two strings made of the cane and which rest upon a sort of wood placed at both ends. It is to be understood that these strings are not taken out of the case but are a part of it; for with great care they will insert the point of the knife where the strings are to be and raising the fiber they will cut a string the size of a match or larger. Under it they will place a small piece of wood upon which the string rests. This is done in the same way at the other end. Thus the two strings are made.

The lantoy is a species of flute. It is made of caña bojo and has two holes. This instrument is played with the nose.

Regarding the Tagbanuas Tandulanos

Besides the mountain Batacs who live near Caruray there is another small tribe known as Tandulanen and who number no more than twenty persons. These people occupy the Bay of Santa Cruz de Mayo, known thus geographically, but whose native name is Tugdunan. This beautiful bay is sheltered by various islands, the principal one being Buhayan and along whose shores live quite frequently the Tandulanos. They are very agile and little in stature. They resemble the Batacs very much even in speech, differing slightly in tone and in some words which they have assimilated from other dialects which are so numerous in this island. They are darker than the Batacs, probably, because they are more exposed to the sun and influence of the sea. They live on headlands, on the beach and in coves. They construct no huts in which to live. They are nomads. They plant nothing, not even rice, which formerly was unknown to them. They cover their loins with the bark of trees. They live upon fish, turtles, shell fish, wild hog, wild animals, and roots of plants. They are very skilled in fishing and hunting. For the former they use the harpoon known as pamulos, which they throw with great skill. They hunt the wild hog by means of the dog and the arrow. They handle the blow-gun and always have it prepared for use against their enemies. The Tandulanos are followed by their wives and children, who are carried in the same way as the Batac women carry theirs. They sleep in whatever place they may happen to be, either upon the sandy beach or in caves among the rocks. When they suffer because of cold or humidity, they build fires around which the families lie. The women give birth without any aid. The men as well as the women are fine navigators. They are children of the sea. Each family has its own baroto or baluto. They always journey together and to whatever

place any one wishes to go, especially if it be an old man who expresses the desire. If during the voyage they meet any small boats, they desire to know who the people may be. If they be friends they will enter into conversation and trading; if they be strangers and suspicious men, they not only repel them but drive them from the spot.

Fifty years ago the Tandulanos were very cruel. They had dealings with no tribe, not even with the Batacs. The only Christian with whom they had friendly relations was the well-known Esteban Castro, a rich land owner, who with much difficulty won the friendship of these savages. They reverence the man to such an extent that in order to enter into trading with them it is only necessary to mention the name of Esteban. It is due to his intelligence and friendship that their cruelty became less and that they entered into commercial relations with the Christians of the north.

The Tandulanos twenty-five years ago were a large family, but the measles which broke out among them in 1882 caused about 80 per cent. of them to die. This disease afflicts them as a plague of small-pox, of which they have great horror.

One of the sicknesses which they greatly fear is catarrh, which in their opinion is incurable and contagious. Formerly, persons thus afflicted were buried alive. Today, however, if a person have this disease he is exiled to a lonely place and provisions are given for a certain number of days. After an interval the people will go to the place of quarantine. If the disease be cured the person can return to his home, but if he still suffers, then he is left there to die without aid or friend. In order to prevent this sickness, visiting strangers are closely examined. If they be well they can enter the dwelling place of the Tandulanos; if sick they are expelled.

During the last few years they have changed many of their ancient customs and have adopted those of the Batacs with whom they come in contact more frequently.

The oldest man in the tribe is their chief and to him are submitted all questions.

During my frequent visits to the abode of the Tandulanos, I have never been so fortunate as to witness a wedding ceremony, but it is the same as among the Batacs. Any kind of a union is legal. A man who is married to his mother (after having become a widow) or sister is considered a worthy man.

This tribe is the lowest of all the tribes of Palawan. They do no kind of work, not even pertaining to their own use, much less do

they engage in any kind of trading. The only thing I know them to do is to hunt the bees, the honey and larvæ of which are their favorite food. The wax they reserve for the traders for which they receive bolos, etc.

A man in order to be rich must have a great number of arms and clothing made of beaten bark.

Lately the Tandulanos, imitating the Batacs and the Christians, have begun to prepare the soil for the planting of squash and camote, but in quantities hardly sufficient to supply their needs during the days of the harvest. It seems as though scarcely having begun to plant a little rice, which is done with no pleasure, they abandon so useful an occupation. This is one reason why they are in such a miserable condition. But there are some of them who during this year have planted vegetables, tubers, and even palay.

The Tandulanos have no musical instruments. Neither do they observe any fiestas.

Because of their hostility and their lack of hospitality in trading with strangers we have little knowledge concerning the customs of the Tandulanos.

The Civilized Tagbanuas or Silanganen

The Silanganen are the Pagbanuas who are civilized and Christianized and who dwell in the barrios of the north, east and west of Palawan. They are found along the coast extending from Babuyan to Silanga in Taytay on the east coast; and from here around the point of Cagbuli to Malampaya on the west. In all the barrios the Cuyono dialect is usually spoken. This dialect has been brought hither by the emigrants from the island of Cuyo, the former capital of the province. Today the Cuyono people are the most numerous, for the original inhabitants have disappeared. I need not speak regarding the habits and customs of the Silanganen, for they have adopted the civilization of the people of Cuyo with whom they have lived in harmony and friendship until this day.

Puerto Princesa, March 30, 1906.

NOTES

Valparaiso Earthquake of August 16, 1906.

Letter to the Smithsonian Institution from Professor Heber D. Curtis, of the D. O. Mills Expedition of Lick Observatory, California.

"Santiago, Chile, Dec. 19, 1906.

" . . . I have just returned from a talk with Professor Greve, of the Observatorio Nacional, who is connected with the Commission.[1] He tells me that a large amount of data has been collected from a considerable portion of Chile and that this material is at present being revised and prepared for publication by Dr. Steffens, of the Universidad de Chile. It is not the intention of the Commission to publish a preliminary report, but to publish their results in the final form.

"From the data collected it seems pretty certain that there has been some elevation of the coast of Chile. This gradual upheaval is a well-known geological fact. Whether the evidence secured by the Commission will prove this upheaval for the entire coast, I do not know, but it seems quite firmly substantiated for certain stretches. The strongest piece of evidence is given by a certain salt works to the south; this formerly made use of the tides to fill the catchment basins; this is now (since Aug. 16th) no longer possible. At another place a sunken launch, formerly awash, is now covered forty to fifty centimeters. The data are not accurately worked up yet; the lifting is probably under one meter.

"The Commission have found no traces of a rift such as caused the earthquake at San Francisco. There have been many surface cracks, but in all cases these can be shown to be merely local translations, occurring in the main near irrigation canals or near rivers. All these small rifts thus far found occur in soft or alluvial soil. A week or so ago I visited Hospital and Graneros, small towns to the south, where the action had been unusually severe, to investigate some such phenomena of which I had heard. I found numerous rifts, but all of local character. A particularly interesting case was observed at Graneros. Here, on the estate of Señor Donoso there

[1] Commission appointed by the Chilean government to make a scientific investigation of the phenomena accompanying the earthquake of August 16, 1906.

is a long avenue flanked on each side by rows of tall poplars. On one side of this road for a distance of about one hundred meters one of the rows was moved bodily about two meters out of line without tilting the tall trees. But the row on the other side of the road still preserves its alignment, and this local translation is due to a small ditch on the side toward which the trees moved and to the generally soft character of the soil here, the surface cracks being numerous and large. . . .

"I do not believe that any great amount of work has been done by the Commission in an actual search for a rift in mountainous country. Where the railroad passes through the mountains, cracks were found and landslides, but these also were evidently local. A painstaking search through mountainous country might possibly bring to light some fault phenomena, though the task would be a difficult one owing to the amount of territory to be covered. That a long rift could have arisen without being noticed at some point seems, however, rather improbable, and it seems quite certain that no evidence has been found of such displacements in the populated districts of the plains and foot hills. Doubtless the resumé of results will make it better possible for you to judge whether further search would be likely to produce any results.

"Very interesting data are available as to the periodicity of the maximum destructive effect, and I understand that such points will be treated in the final report of the Commission. A number of cases have been brought to my knowledge by Mr. S. E. Hyslop, No. 1078 Huerfanos, Santiago: he is an electrical engineer and has had opportunity to make intelligent and valuable observations on such points. Near Catemu he found several particularly striking cases. Here there were long adobe walls running approximately N. E. by S. W. For quite a long distance pieces have been "bitten," as it were, out of the walls. The pieces bitten out average 1.8 meters in length and their average distance apart is quite regular, averaging 9 meters. Another wall in the same district gave a 'period' of 7 meters. In the case of parallel walls bounding another road in the same district, the portions thrown down average 2 meters in length and are about 8 meters apart. The road is 10 meters wide and the destroyed portions are not even but displaced along the road by about 17 meters. The road runs N. E. by S. W.

"Instances of this sort could be multiplied, but will doubtless be treated in the Report of the Commission."

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